SCIENCE

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CONTENTS:

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*THE ECONOMIC STATUS OF INSECTS AS A CLASS.**

THE popular conception of insects in general is undoubtedly that they are injurious. Many writers, it is true, have pointed out the benefits derived from insects, but we think of their damage to crops and of their annoyance to man and animals, and this aspect of the subject is at once apt to preponderate in our minds. It is more than 80 years since Kirby and Spence contrasted the injuries caused by insects with the benefits derived from them, and it has not been comprehensively done since. In the meantime, whole groups of important injuries have been developed and whole classes of beneficial work have been discovered. Moreover, the tendency of modern thought has not taken this direction. The biologic, taxonomic and phylogenetic, and other aspects of large groups of forms of life have been considered to the exclusion of the economic aspect, and even where this side has attracted attention investigators have confined themselves to specific problems and have not generalized. It may be interesting, therefore, once more to contrast the injurious insects with the beneficial ones in an effort to gain a clearer idea of the status of the group in its relations with man.

In a broad way, we may consider the subject under the following heads:

* Address of the retiring President of the Biological Society of Washington, delivered January 18, 1899.

Insects are injurious:

1. As destroyers of crops and other valuable plant life.
2. As destroyers of stored foods, dwellings, clothes, books, etc.
3. As injuring live stock and other useful animals.
4. As annoying man.
5. As carriers of disease.

Insects are beneficial:

1. As destroyers of injurious insects.
2. As destroyers of noxious plants.
3. As pollenizers of plants.
4. As scavengers.
5. As makers of soil.
6. As food (both for man and for poultry, song birds and food fishes) and as clothing, and as used in the arts.

DESTROYERS OF CROPS AND OTHER USEFUL PLANTS.

In the present balance of nature one of the chief functions of insect life is to keep down superabundant vegetation. Almost every kind of plant has its insect enemies, and has had such enemies for many thousands of years. So soon as man began to make an effort to upset nature's balance by cultivating certain plants at the expense of others he encountered nature's opposition by means of the increase of insect enemies of the particular plant cultivated, and almost as early as there is any record of agriculture in literature there is also mention of the destruction to crops caused by insects. Witness the writings of the prophet Joel, who might almost be termed an agricultural pessimist.

At the present time almost every cultivated crop has not only its thousands upon thousands of individual insect enemies, but it is affected by scores and even hundreds of species. A mere tabulation of the insect enemies of the apple already recognized in this country shows 281 species, of clover 82 species, and of so new a crop as the sugar beet 70 species. The insects of the vine, of the orange, of the wheat crop, and, in fact, of all of our prominent staples, show equally startling figures.

The actual damage which is done by insects in this way is difficult to express. Many attempts have been made by writers on economic entomology to express it in money values. For example, it was estimated by the late Professor Riley that the average annual damage to cultivated crops by injurious insects in the United States amounted to three hundred millions of dollars. The loss from the ravages of one species alone, the chinch bug, during one year was estimated at sixty millions of dollars. While it is true that the combined losses of individual growers might reach such enormous sums as these, there is an element in the total loss which we must not fail to take into consideration, and that is the enhanced value of the portion of the crop which remains. Even in the case of an individual a man may lose, for example, half of his crop through the work of the chinch bug, and yet, through widespread damage by this insect, the money value of the portion harvested may reach an amount almost as great as would have been gained through the low prices of a successful year of no insect damage. As this applies to an individual, it applies much more strongly to a State or to the country at large, so that even in the year when the grain crop of the country was said to have been damaged to the extent of sixty millions of dollars it is safe to say that the total price gained for the crop was as great as it would otherwise have been. These estimates of damage, therefore, would much better be expressed in terms of bushels, or some other measure, than in money value.

It is this aspect of our subject, the damage done by injurious insects to agriculture, that has given rise to the comparatively new branch of applied science which we

now know as economic entomology, and which, although originating in Europe, has been encouraged to such an extent in our own country, owing partly to our greater necessities and partly to our practical turn of mind, that it is safe to say that at present America leads the rest of the world in this direction.

It is undoubtedly true that this enormous injury to crops is the chief item in a general consideration of the injuries brought about by insects.

AS DESTROYERS OF STORED FOODS, DWELLINGS, CLOTHES, BOOKS, ETC.

It is safe to say that there is hardly any product of man's ingenuity, hardly one of the thousands of useful materials upon which depend his comfort and happiness, which is not damaged, directly or indirectly, by insects. The timbers of which his dwellings are built, nearly all of his household utensils, his garments, practically everything which he uses as food, many of the liquids used as drink, his books, the ornaments with which he surrounds himself, the medicines which he takes when sick, the very tobacco with which he solaces himself—all are destroyed or injuriously affected by insects. There is, perhaps, one group of exceptions, and that is those articles which are composed wholly of metal, and yet even here insects may occasionally play an injurious part, since instances are on record of the destruction of lead pipes by insect larvæ, and the perforation of the metal linings of water tanks by small beetles.

Such injuries to human products are more frequent and serious in tropical regions than in temperate zones, but even here insects of this nature cause very serious inconvenience and great annual loss. It will answer our purpose, perhaps, to list some of the varying substances which are damaged in this way, to get an idea of their almost universal character: Ham, cheese, salted fish, butter, lard, dried mushrooms, rye bread, sweetmeats and preserves, powdered coffee, almonds and other nuts, raisins, breakfast foods, chocolate, ginger, rhubarb, black pepper, vinegar, sugar, wines, canned soups, tobacco, snuff, licorice, peppermint, aromatic cardamon, aniseed, aconite, belladonna, musk, opium, ginseng, chamomile, boneset, hides, shoes, gloves and other leather articles, furniture, carpets, drawings and paintings, paint brushes, gun wads, combs, etc., made of horn; hay, oats, straw, willow baskets, ax handles, ladders, wheel spokes and all sorts of agricultural implements with wooden handles, barrels, wine casks, corks of wine bottles, sheets of cork, natural history collections, including skeletons and mummies, and even Persian insect powder! The mention of this well-known insecticide reminds one of the latest discovery, which is that certain flies in California breed in the crude petroleum pools in the vicinity of oil wells, a fact which is almost paradoxical in view of the extensive use of petroleum as an insecticide.

AS INJURIOUS TO LIVE STOCK AND OTHER USEFUL ANIMALS.

Every species of animal which has become domesticated and is of value to man possesses its insect parasites and enemies. These in many cases are the same species which affect man and which we will mention in the next section; others are specific to the animals or groups of animals which they affect. Horses, cattle, sheep, all possess insect enemies which are not only very deleterious to their health, but frequently cause their death in numbers.

The disgusting bot fly of the horse, whose maggots live in incredible numbers in the stomach and intestines of this noble friend of the human race; the bot fly of the ox, which causes innumerable sores on the backs of cattle and by its perforations ruins

their hides for commercial use; the bot fly of the sheep, which inhabits the nasal and orbital sinuses of the sheep and produces insanity and death—will instantly be recalled by those who are familiar with stock raising, while hundreds of other species, some in no less degree, as the horn fly, the numerous gad flies, including the Tsetse fly of Africa, the screw worm fly of our Southwestern country, unite to make the lives of domestic animals a burden to themselves and a trial and a loss to their owners.

An interesting attempt was made some years ago by a prominent Western agricultural newspaper, *The Farmers' Review*, to estimate approximately the pecuniary loss from the attacks of a single one of these insects—the ox bot fly, or ox warble—on the cattle received at the Union Stock Yards, of Chicago. It was estimated that 50 per cent. of the cattle received each year are affected. The number of cattle received at the yards during six months of the year 1889 was 1,335,026; the average value of the hide was $3.90; the usual deduction for hides damaged by the ox warble was one-third. Estimating at less than one-third, say $1.00, the actual loss during six months on hides alone was $667,513. When to this was added the loss for depreciation in value and lessened quantity of beef, the loss for each infested animal was put at $5.00, a very low estimate, indicating the total loss from the animals in the Union Stock Yards, of Chicago, for a period of six months of $3,336,565.

AS ANNOYING MAN.

There are very few regions of the habitable globe where man is not personally subject to more or less annoyance by insects. In this part of the world we naturally think at once of mosquitoes, house flies, fleas, and of a certain other species which it will not be necessary to name.

A susceptible individual some years ago wrote to the Department of Agriculture and said that he had come over from the old country and settled in New Jersey, but that the mosquitoes bothered him so greatly that on the advice of friends he moved to northern New York. Here he found that during a certain portion of the year black flies made life unendurable; thereupon he packed his household effects and moved to North Carolina. Here, however, in the summer months red bugs, or jiggers, bothered him to such an extent that he feared he would go crazy, and in this desperate condition he applied to this office to learn whether there existed in the United States a locality where a sensitive individual could find peace from attacks of insects. He said that he had been told that in the Western country the buffalo gnat was greatly to be feared, while certain other biting flies would be sure to keep him in a constant state of dermal irritation; that further south he knew that peaceful nights were to be gained in the summer time only under the protection of mosquito bars. He had thought of the newly developing country of Alaska, but had recently seen an account in the newspaper of the ferocity of the Alaskan mosquitoes, which had practically destroyed his last hope.

Accustomed as most of us are to the mosquitoes of temperate North America, we hardly realize the impression which they made upon the early English travellers. A story told by Kirby and Spence, to the effect that Mr. Weld in his travels relates from General Washington that in one place the mosquitoes were so powerful as to pierce through his boots, has always excited my interest and curiosity, and I recently took the trouble to consult the original publication, which is 'Isaac Weld's Travels through North America, 1795–1797,' London, 1799. In speaking of Skenesborough, in northern New York, Mr. Weld dilates upon the number and ferocity of the mosquitoes, and

makes use of the following words: "General Washington *told me* that he never was so much annoyed by mosquitoes in any part of America as in Skenesborough, for that they used to bite through the thickest boot." Now, knowing that the boots of those days were very thick and that the mosquitoes of that time must have been structurally identical with those of to-day, there arises instantly a question of veracity between Mr. Weld and General Washington; and as we know from Dr. Weems' veracious history that General Washington was so constituted that he could not tell a lie, it looks very much as though Mr. Weld, like many another English traveller who has written a book on his return home, has been inclined to overstate the truth.

In these days of comparative personal cleanliness some of the most disgusting of the insect annoyers of man have dropped out of sight. The lice, which in former days were common in all classes of society, from king to peasant, are now comparatively unknown. The itch disease, which carried off many a famous character in history, is equally rare. That it still persists, however, is shown by an occasional case reported in medical journals. For example, Dr. Robert Hessler, of Indianapolis, reported in 1892 a case in his own practice of typical Norway itch in which the itch mites were present in the skin of the patient in enormous numbers. A rough estimate showed seven million eggs and two million mites.

Those of us who live in a reasonably civilized way are confined, in our experience of annoying insects, largely to the forms mentioned in our opening paragraph, namely, mosquitoes and house flies and rarely fleas; but a glance through the medical literature reveals the existence of more or less frequent cases of such a nature that they are little less than horrible. Prominent among these are the cases of so-called Myasis, and especially those resulting from the attacks of the screw worm fly, *Compsomyia macellaria*.

Residents of temperate regions are fortunate as compared with those of tropical regions in respect to the personally annoying insects. Our troubles from these individually insignificant causes are intensified to a degree in warmer countries, where the comfort of the individual absolutely depends upon the adoption of measures, always difficult and frequently impracticable, to exclude insects from his person and from his food. This is so well known in these days of numerous books of travel that I will close this aspect of our question simply with a quotation from a poet of the Indies, written many years ago:

"On every dish the booming beetle falls,
The cockroach plays, or caterpillar crawls:
A thousand shapes of variegated hues
Parade the table and inspect the stews.
To living walls the swarming hundreds stick,
Or court, a dainty meal, the oily wick;
Heaps over heaps their slimy bodies drench,
Out go the lamps with suffocating stench.
When hideous insects every plate defile,
The laugh how empty, and how forced the smile!"

AS CARRIERS OF DISEASE.

Manson's demonstrated transmission of the filaria diseases of the East (elephantiasis, chyluria and lymph scrotum) by insects; the discovery by Salmon and Smith of the carriage of the germ of Texas fever by the well-known Southern cattle tick; the discovery by Koch of the fact that the Tsetse fly of Africa is so destructive to animals, not by its bite alone, but by carrying into the circulation of the animal that it attacks the micro-organisms of disease; the demonstration by Howe and others of the previously suspected fact that the purulent conjunctivitis of the Egyptians is spread by the house fly; the partly proven hypothesis of Manson and Grassi of the relation existing between mosquitoes and malaria; the circumstantially proven carriage of the

germs of Asiatic cholera and typhoid fever by flies; the demonstration claimed by Finlay of the carriage of a mild type of yellow fever by mosquitoes; the suggestion by Hubbard that the 'pink eye' of the South is spread by Hippelates; the well-recognized fact among the Europeans of the Fiji Islands that without a veil a serious native eye disease will spread through the medium of gnats; the suggestion by Symond of the agency of fleas in the spread of the bubonic plague; the demonstration of anthrax bacilli in malignant pustules in human beings, caused by the bite of Tabanus and Stomoxys—all indicate an important and very injurious function of insects practically unsuspected until comparatively recent years. It is, in fact, a rapidly increasing field of investigations, the possibilities of which cannot be accurately established at the present time. It is, however, not a field which should be left entirely to the medical bacteriologist; the entomologist should have a share. The life histories and habits of the insects concerned in the damage should be thoroughly understood, since it is not impossible that otherwise the medical investigators may find themselves arriving at perhaps unwarranted conclusions. For example, it is a fact probably unknown to the medical men who may be strongly impressed by the suggested carriage of typhoid germs by flies, that the house fly, so common in our dining rooms, does not breed in and rarely visits human excrement, while those other kinds of flies, which do so breed, are rarely attracted to articles of food used by human beings. In the crowded and unnatural conditions of army camps, however, and especially where cavalry regiments are stationed, so that there are great amounts of horse manure, the house fly may breed in such enormous numbers as to render of very likely occurrence a departure from the normal food habits of the adult.

Enough has been shown, however, to emphasize the potentiality of this phase of insect injury.

BENEFITS AS DESTROYERS OF INJURIOUS INSECTS.

The economic bearings of insect enemies of insects are very great, and perhaps this is, all things considered, the most important of the beneficial function of insects as a class.

In the eternal warfare of organism upon organism, in the perpetual strife of species, one preying upon another and that upon a third, the complications of relations of forms which determine the abundance of one species and the scarcity of another are nowhere more marked than among the insects. In fact, to the student of insects who has followed out even a single chain of these inter-relationships the thought must necessarily come that upon its organic environment, and especially upon its relations with its living neighbors of the animal kingdom, depend the chances of a species not only for increase, but for survival almost to no lesser degree than upon its inorganic environment. Temperature is the great factor which controls the geographical distribution of life, and temperature is at the back of all these apparent living first causes which control the abundance of a species in a given region, provided we trace them far enough. Yet these living causes, themselves affected by other living causes in an almost endless chain, sometimes, to all appearance, dwarf even temperature as a controlling factor.

There is not a species of insect that has not its natural enemies in the guise of other insects; there is not one of these other insects which has not its own insect foes. From a single species of Bombycid moth, the larvæ of which frequently damage forests in Europe to an alarming extent, there have been reared no less than sixty species of hymenopterous parasites. From a

single caterpillar of *Plusia brassicæ* have been reared 2,528 individuals of a little hymenopterous parasite, *Copidosoma truncatellum*.*

Outbreaks of injurious insects are frequently stopped as though by magic by the work of insect enemies of the species. Hubbard found, in 1880, that a minute parasite, *Trichogramma pretiosa*, alone and unaided, almost annihilated the fifth brood of the cotton worm in Florida, fully ninety per cent. of the eggs of this prolific crop enemy being infested by the parasite. Not longer ago than 1895, in the city of Washington, more than ninety-seven per cent. of the caterpillars of one of our most important shade-tree pests were destroyed by parasitic insects, to the complete relief of the city the following year. The Hessian fly, that destructive enemy to wheat crops in the United States, is practically unconsidered by the wheat growers of certain States, for the reason that whenever its numbers begin to be injuriously great its parasites increase to such a degree as to prevent appreciable damage.

The control of a plant-feeding insect by its insect enemies is an extremely complicated matter, since, as we have already hinted, the parasites of the parasites play an important part. The undue multiplication of a vegetable feeder is followed by the undue multiplication of parasites, and their increase is followed by the increase of hyperparasites. Following the very instance of the multiplication of the shade-tree caterpillar just mentioned, the writer was able to determine this parasitic chain during the next season down to quaternary parasitism. Beyond this point, true internal parasitism probably did not exist, but even these quaternary parasites were subject to bacterial or fungus disease and to the attacks of predatory insects.

The prime cause of the abundance or scarcity of a leaf-feeding species is, therefore, obscure, since it is hindered by an abundance of primary parasites, favored by an abundance of secondary parasites (since these will destroy the primary parasites), hindered again by an abundance of tertiary parasites, and favored again by an abundance of quaternary parasites.

The subject of practical handling of insect enemies of insects has come into great prominence during the past ten years. The suggestion by the Rev. Dr. Bethune, of Canada, many years ago, of the desirability of importing the European parasite of the wheat midge into America was probably the first published international suggestion of this nature, and, although some subsequent correspondence between English and American entomologists ensued, no parasites were actually sent over. Later, attempts were made by LeBaron in the case of a parasite of the oyster-shell bark-louse of the apple, and by Professor Riley in the case of a parasite of the plum curculio, to transport parasites from one section of the United States to another, both attempts meeting with some slight success.

In 1873 Planchon and Riley introduced an American predatory mite, which feeds in this country on the grape vine *Phylloxera*, into France, where it became established, but where it accomplished no appreciable results in the way of checking the spread of this famous vine pest.

In 1874 efforts were made to send certain parasites of plant-lice from England to New Zealand, without recorded results of value.

In 1880, in an article upon the parasites of American scale insects, the writer showed that international transportation is especially easy, and especially desirable in the case of these insects.

* This observation, which for some years 'held the record,' as the expression is, was made by Mr. Pergande, of the U. S. Department of Agriculture. Recently, however, Professor A. Giard, of Paris, has more than 3,000 specimens of the same parasite reared from a Plusia caterpillar.

In 1883 Dr. Riley succeeded in importing a common European parasite of the imported cabbage worm into this country, where it established itself and has since proved to be a valuable addition to our fauna.

In 1891 the same distinguished entomologist brought about the importation of one of the European parasites of the Hessian fly through the assistance of Mr. Fred. Enock, of London. This parasite maintained itself in this country certainly as late as 1895, but has accomplished no appreciable good, so far as has been ascertained, in limiting the increase of this destructive enemy to wheat.

All previous experiments of this nature were dwarfed into insignificance by the astounding success of the importation of *Novius* (*Vedalia*) *cardinalis*, a ladybird beetle, from Australia into California in 1889. This importation was made, as will be remembered, by Mr. Albert Koebele, an attaché of the Division of Entomology of the United States Department of Agriculture, whose expenses, however, were paid out of a fund appropriated to the Department of State, for the purpose of securing a representation from this country at the Melbourne Exposition. A California man, the late Mr. Frank McCoppin, happened to be at the head of the Exposition Commission; and, while the late Dr. C. V. Riley was endeavoring in Washington to induce the Department of State to set aside a sum, from the Exposition fund, for the expenses of Mr. Koebele, representatives of the State Board of Horticulture of California were pressing the same facts upon Mr. McCoppin, the head of the Commission. These efforts were being made independently and without consultation, hence it happened that after Mr. Koebele had succeeded in sending live Vedalias to California, and after these insects, by their rapid multiplication and voracious habits, had absolutely destroyed the cottony cushion scale in the orange groves of the State, a result which practically saved millions of dollars to California, and which attracted the attention of everyone interested in science or agriculture, a most unfortunate controversy ensued between Dr. Riley and the California State Board of Horticulture as to the placing of the credit of carrying out this wonderfully successful experiment. This controversy embittered the last days of both Dr. Riley and Mr. McCoppin, and was the cause of a disturbance of the formerly pleasant relations between the United States Department of Agriculture and the State Board of Horticulture of California, which has only recently been overcome.

Following this successful experiment, the same insect, *Novius cardinalis*, was sent to South Africa, where it exterminated the white or fluted scale in that colony. The next year it was sent to Egypt, where it exterminated a congeneric scale insect in the gardens of Alexandria.

The following year Mr. Koebele, still an agent of the United States Department of Agriculture, was sent with the consent of the Honorable Jeremiah Rusk, but at the expense of the California State Board of Horticulture, to Australia, New Zealand and the Fiji Islands, for the purpose of securing other valuable beneficial insects for importation into California. Thousands of such insects, comprising a number of different species, nearly all, however, of them Coccinellids, or ladybirds, were sent over and established in California. Several of these species are still living in different parts of the State. The overwhelming success of the importation of *Novius cardinalis* was not repeated, but one of the insects brought over at that time, namely, *Rhizobius ventralis*, has unquestionably ridden many olive groves of the destructive black scale, and is to-day present in many other orchards in such numbers that the scale practically makes no headway.

After this second Oriental trip the relations between the Department of Agriculture and the State Board of Horticulture of California became so strained that the California agents of the Department were given their choice by the Honorable Secretary of Agriculture to resign their positions or be transferred to Washington. Mr. Koebele resigned and was soon after employed by the then newly established Hawaiian Republic for the purpose of travelling in different countries and collecting beneficial insects to be introduced into Hawaii for the purpose of destroying injurious insects. It is difficult at this time to ascertain the exact results of the more recent portion of this work. Mr. Koebele's own published reports have dealt less with results than with the details of the introduction of insects, and anonymous newspaper reports are not to be accepted as scientific evidence. Fortunately, however, one of the collectors of the British Association for the Advancement of Science, Mr. R. E. C. Perkins, was in Hawaii during 1896 and made a report on Mr. Koebele's work to the committee appointed by the Royal Society and the British Association for investigating the fauna of the Sandwich Islands, which was published in *Nature* for March 25, 1897. From this report it appears that the introduction of *Coccinella repanda* from Ceylon, Australia and China was so successful in the extermination of plant-lice upon sugar cane and other crops as to obviate all necessity for spraying. The introduction of *Cryptolæmus montrouzieri* from Australia resulted in the entire recovery of the coffee plants and other trees which were on the point of being totally destroyed by the scale insect known as *Pulvinaria psidii*. Eight other introduced species had at the date of writing (November, 1896) been entirely naturalized and were reported as doing good work against certain scale insects. A Chalcis fly, *Chalcis obscurata*, introduced from China and Japan, multiplied enormously at the expense of an injurious caterpillar which had severely attacked banana and palm trees. Mr. Koebele, when visiting Washington during November, 1898, mentioned a number of other importations of beneficial insects into Hawaii, about which it is as yet too early to speak.

A very recent instance of an international importation of striking value is the sending of *Novius cardinalis* from this country to Portugal, where the white or fluted scale has been checked and in many orchards exterminated in the course of a single year. This importation was made by the writer with the invaluable assistance of the California State Board of Horticulture.

Other experiments in this line are under way. A parasite of certain wax scales, which are abundant and injurious in the South, has been imported by the writer from Italy, with the cooperation of Professor Antonio Berlese, of the Royal Scuola di Agricoltura di Portici; while an effort is being made to bring from Europe insects which will prey upon the Gipsy moth which has been so great a plague about Boston; and other parasites of injurious scale insects in foreign countries are being studied with the purpose of eventually obtaining their introduction into the United States.

AS DESTROYERS OF NOXIOUS PLANTS.

Just as we have shown how important is the rôle played by insects in the destruction of cultivated and useful plants, it will be easy to indicate their importance as destroyers of weeds and other noxious plants. We need only mention the common and cosmopolitan thistle butterfly (*Pyrameis cardui*), the equally common milkweed butterfly (*Anosia plexippus*), the purslane caterpillar (*Copidryas gloveri*), the burdock beetle (*Gastroidea cyanea*), and the purslane sphinx moth (*Deilephila lineata*) to recall to the mind of the experienced entomologist many

other species which do similar work. They are here, as in the former case, perhaps the principal agents in preventing the undue increase of any one species of plant, but as we find here not an effort of man to combat Nature, as it were, by increasing the growth and spread of one species at the expense of the others, but the exact opposite, so, here also, to a degree we find Nature arrayed against man, and insects thus play by no means the same part in the destruction of weeds that they do in the destruction of cultivated crops. Nevertheless, they have an important function in this direction, and it is safe to say that the benefit which the agriculturist derives from their work in this way is very great. As long ago as the beginning of the century it was pointed out by Sparrman that a region in Africa, which had been choked up by shrubs, perennial plants and hard, half-withered and unpalatable grasses, after being made bare by a visitation of destructive grasshoppers, soon appeared in a far more beautiful dress, clothed with new herbs, superb lilies and fresh annual grasses, affording delicious herbage for the wild cattle and game.

In a similar way Riley has called attention to the fact that after the great grasshopper invasions of Colorado and other Western States in the years 1874 to 1876 there were wonderful changes in the character of the vegetation, the grasshopper devastations being followed by a great prevalence of plants which in ordinary seasons were scarcely noticed. It is true that some of these plants were dangerous weeds, but others were most valuable as forage for the half-starved live stock. Moreover, other plants, and especially short or recumbent grasses, took on a new habit and grew luxuriantly; one species, for example, *Eragrostis poæoides*, ordinarily recumbent and scarcely noted, grew in profusion to a height of three and a-half feet.

An important, but not generally realized, benefit which is derived from the insects may be mentioned under this head, though not strictly belonging here. Kirby showed, 75 years ago, that the insects that attacked the roots of grasses, such as wireworms, white grubs, etc., in ordinary seasons only devour so much as is necessary to make room for fresh shoots and the product of new herbage, in this manner maintaining a constant succession of young plants and causing an annual though partial renovation of our meadows and pastures, "so that, when in moderate numbers, these insects do no more harm to the grass than would the sharp-toothed harrows which it has sometimes been obliged to apply to hide-bound pastures, and the beneficial operation of which in loosening the subsoil these insect borers closely imitate."

AS POLLENIZERS OF PLANTS.

It can no longer be doubted that cross fertilization is one of the very most important elements in the progressive development and continued health of the great majority of flowering plants, and, indeed, that it is with some almost a condition of existence. Opposition to this view, at no time especially strong since the publication of Darwin's great work, has become feebler and more feeble until at the present it is not worth considering.

Comparative experimentation with self-fertilizing and cross-fertilizing plants, repeated with many species and genera, have shown a superior growth and vitality on the part of those subjected to cross-fertilization of such a degree as to leave not a semblance of a doubt; while in individual cases self-fertilization has been scientifically shown to even result in a deterioration so marked that it has been compared to poisoning.

In this condition of affairs it at once becomes evident that the good offices of insects in this direction are of incalculable

importance, since it must be plain that of the natural agencies by which cross-fertilization of plants is accomplished insects are far and away the most prominent. Every investigation which has been undertaken of recent years, and activity in this field is increasing by leaps and bounds, has shown the most marvelous adaptations between the structure of flowers and the structure of their insect visitants, all in the line of facilitating or really enforcing the collecting and carriage of pollen by flower-visiting insects from one plant to another. An estimate of the numbers of the species of insects engaged in this work would include the forms belonging to whole families and almost orders, and if we could imagine the race of flower-visiting insects wiped out of existence the disastrous effect upon plant growth would be beyond estimate. I am not prepared to state that insects benefit plants in this way to such an extent as to overcome the results of the work of the plant-destroying species, but if it were possible to compare in any way the results of these two classes of work it is safe to say that the effect would be surprising.

We must, therefore, without going further into detail, place this pollenization of plants as one of the very most important beneficial functions of insects in their relations to man.

AS SCAVENGERS.

Another beneficial function of insects, the importance of which can hardly be overestimated, is their value to humanity in doing away with, and rendering innocuous, dead matter of both plant and animal origin. This subject has never been discussed without reference to the famous statement by Linnæus that the offspring of three blow-flies would destroy the carcass of a horse as quickly as would a lion; and while the exact statement in its details is open to doubt, still it serves to illustrate, in a striking way, the good offices of insects, and it is certainly true that after the offspring of the blow-fly have finished with the horse's carcass this would be left in a much less offensive condition than after the departure of the lion.

There are inhabited regions in which the climate is so dry that dead bodies of animals never become offensive, but, by natural mummification, remain simply as cumberers of the earth. In such regions insects play little part. Wherever, however, there is sufficient moisture to produce a natural decay, there insects occur in swarms and hasten the destruction of the decomposing mass in a marked degree. Were the bodies of dead animals not destroyed by insects in this way, and, still more, were the destruction of dead vegetation not hastened as it is by the attacks of countless insects, it is perfectly easy to see that the earth would not be inhabitable, its surface would be covered with the indestructible remains of what was once life in some form.

Large groups of insects, comprising many thousands of species, take part in this inestimable work, and it will probably be unnecessary in order to bring about a realization of this value to dwell further upon the subject.

AS MAKERS OF SOIL.

It is a fact not generally realized that insects must take an important part in the changes in the character of the soil which are constantly going on. Occurring in such countless millions, as they do, constantly penetrating the soil in all directions, frequently dragging vegetation below the surface and bringing the subsoil up to the surface, changing the character of the soil humus by passing it through their bodies, and fertilizing the earth by their own death and decay, it is probable that insects are responsible for even more soil change than are the earth worms, which Darwin has placed before us in such an important light.

Insects are found beneath the ground in

incredible numbers; some of them pass their whole life underground, feeding upon roots and rootlets, upon dead and decaying vegetable matter, upon soil humus and upon other insects; many of them have their nests underground, although they get their food elsewhere; while others hide their eggs or pupæ underground.

The depth to which they penetrate is something surprising; the minute insects of the family Poduridæ have been found swarming literally by the million at a depth of six to eight feet in a stiff clay subsoil.

AS FOOD AND CLOTHING AND AS USED IN THE ARTS.

In this rôle insects play an important part. Insects as food, and their products as clothing, are well known to all. The great silk industry of the world is derived wholly from insects, and almost entirely from a single species, the silkworm of commerce.

As food, insects have formed articles of diet for certain savage peoples since the beginning of the human race. Hope, in 1842, catalogued forty-six species of insects used as food, and Wallace, in 1854, showed that insects of six different Orders were used as food by the Indians of the Amazon. Semi-civilized peoples to-day use certain insects as food, as witness the consumption of Corixa eggs by the Mexicans, and a book has been written under the caption 'Why not eat insects?' for the purpose of showing that many possibilities in the way of dietetics are being ignored to-day. M. de Fontvielle, in addressing the Société d'Insectologie, in 1883, expressed regret that the attempts made to popularize the use of insects as food have made so little progress, and said that we ought not to forget the remark of the Roman Emperor who said that the body of an enemy never tasted bad, and that the banquet of the Society would always lack something so long as there was not placed before them at least some grasshopper farina and fried white worms.

A single insect, the honey bee, furnishes a notable article of food, and is the basis of a great and world-wide industry.

As food for poultry, song birds and food fish, insects are indirectly of great benefit to man. Not only do they provide living food for such animals, but *Corixa mercenaria*, a water bug, is now being imported by the ton from Mexico into England as food for birds, poultry, game and fish. One ton of these bugs has been computed by Mr. G. W. Kirkaldy to contain 250,000,000 of insects (*Entomologists' Monthly Magazine*, August, 1898).

In the days of pure empiricism in medicine, insects were used extensively, and we have only to mention the Spanish fly to show that they are still of some value.

In the arts, shellac and Chinese white wax, as is well known, are insect products, as also are the formerly greatly used cochineal dye and Polish berry dye, the so-called berry in this case being an insect and not a berry.

The last-named instances are all derived from scale insects, a group of astonishing capacity for multiplication, the commercial possibilities of which are by no means exhausted, as I took pleasure in showing in a paper read before the American Association for the Advancement of Science in 1897. It should be noted here, also, that there is good reason to believe that the manna of the Bible, upon which the Children of Israel subsisted while in the Wilderness, was also the secretion of a scale insect.

SUMMARY OF THE HABITS OF INSECTS.

After this general account, arranged under the classes of damage and classes of benefits brought about by insects, it will be well to attempt an arrangement of the subject in a somewhat different manner, in order to gain,

if possible, some light as to the relative proportion of insects which are injurious or beneficial.

It will be manifestly impossible to catalogue the species or the genera in this way, and it will be obvious that a classification from families will be lacking in exactness, since some of the families are very large in number of species and others exceedingly small; but, taking the groups as a whole, no better and speedier means suggests itself than to summarize the habits by families.

Another difficulty, however, which arises in such a classification is the fact that some orders are in a much more advanced stage of classification than others, and the force which is given to a family as a taxonomic group varies with the views of the latest monographer. Nevertheless, taking only the older and generally accepted families and analyzing habits, we find the situation to be as follows:

Of 33 families of Hymenoptera, but two are strictly plant-feeding; the Cynipidæ, or gall flies, are in the main injurious to plants, but some forms are parasitic; nine families are strictly parasitic upon other insects; fifteen are predatory upon other insects; two, comprising the bees, have no other especial value in their relations with man than as pollenizers of plants, or producers of honey; three, comprising the ants, are beneficial as scavengers, but injurious in their other relations. It must be remembered, however, that at least 27 of the 33 families are of the greatest value in the cross-fertilization of plants, in which work the insects of this order perhaps take the lead.

In the Coleoptera, or beetles, considering 82 families, the insects of nine families on the whole are injurious, and of 23 families on the whole are beneficial as destroying injurious insects; 10 families are beneficial as scavengers, and 30, or more, mostly small groups of little importance, contain some scavengers and many neutral forms of practically no economic importance, although certain of them visit flowers; two families contain both injurious and beneficial forms, as well as many that are neutral.

In the Siphonaptera, or fleas, the species of the single family are parasitic upon warm-blooded animals.

In the Diptera, or true flies, if we classify the families according to habits of the majority of the species in each, we get approximately: injurious families, 10; predaceous families, 11; parasitic family, 1; scavengers, 19. In point of numbers, of individuals in this order, as well as in the Coleoptera, no doubt the injurious will exceed the predaceous; while in the Diptera the scavengers will probably equal all of the others put together.

In the Lepidoptera practically all of the 60 odd families are injurious through the damage done by their larvæ to vegetation, but here again it must be remembered—and the same comment holds for many of the Diptera which we have just considered—that the adult insects are among the most active and frequent visitors of flowers and have a great and beneficial effect on cross-fertilization.

In the Trichoptera the insects of the single family feed upon aquatic plants and have no economic value except as furnishing food for food fishes.

The insects of the single family in the order Mecoptera are indifferent in their economic relations, though probably slightly beneficial.

In the Neuroptera all of the seven families are beneficial through their predaceous habits, with the exception of the Sialidæ, which, since their larvæ are aquatic, may be termed indifferent or neutral, though it has both a beneficial and an injurious relation to food fishes.

In the Homoptera we have nine families, all of which are injurious except that here

and there a species has had a commercial value, like the lac and dye insects.

In the Heteroptera there are 11 families which are strictly plant feeders; 8 are strictly predaceous; 3 are both injurious and predaceous; while the economic value of 13 is more or less doubtful. Most of these last are aquatic and have some value as fish food.

The insects of the single family of the order Physaptera are injurious.

In the Orthoptera we have one family of strictly predaceous habits; one which has a mixed food and is partly injurious and partly beneficial as its species become scavengers; the habits of 1 family are unknown; while in the 4 remaining families the species are all injurious as destroyers of vegetation.

The insects of the single family of the order Euplexoptera are probably beneficial as predatory forms and scavengers.

The single family of the order Mallophaga is injurious, containing parasites of birds and mammals.

In the Corrodentia the habits of the insects of the single family are on the whole of little economic importance, though the species are to be classified in the main as scavengers.

In the Isoptera the forms belonging to the two families are injurious.

In the Order Plecoptera the species of the single family are practically neutral in their economic relations, although they possess some value as fish food.

All of the insects of the single family of the order Odonata may be called beneficial; the adults are predaceous upon other insects and are thus strictly beneficial, but the larvæ may in a sense be termed injurious, since they are aquatic and prey upon other aquatic insects which themselves may be food for fishes.

The insects of the single family of the order Ephemerida are of little economic value, except that they are important fish food.

Lastly, the insects of eight of the families of Thysanura are beneficial as scavengers and soil markers, while some of the species of one family are somewhat harmful from the damage which they do in households.

Tabulating the facts thus gained we have the following:

Injurious as feeding upon cultivated and useful plants, the insects of 112 families.

Injurious as parasitic upon warm-blooded animals, the insects of 1 family.

Beneficial as preying upon other insects, the insects of 79 families.

Beneficial as scavengers, the insects of 32 families.

Beneficial as pollenizers only, the insects of 2 families.

Beneficial as forming food for food fishes, the insects of 3 families.

Of undetermined economic importance, the insects of 49 families.

Families containing both injurious and beneficial forms, 22.

The totals are:

Beneficial, the insects of 113 families.

Injurious, the insects of 116 families.

Both, or undetermined, the insects of 71 families.

CONCLUSION.

And now the question is: Are we any nearer the answer of the query in the title of this paper than we were at the start? We have, perhaps, gained by this summary a clearer idea of the economic importance of the class Insecta, and possibly it may appear by this contrasting method that the benefits derived from insects entirely offset their injuries; but we cannot, in our present stage of enlightenment (and I say it with all reverence), complacently and piously adopt, with the good old rector of Barham, the view that insects, with all the lower animals, were created for man's benefit, God permitting occasional injuries, to use Kirby's

words, "not merely with punitive views, but also to show us what mighty effects he can produce by instruments so insignificant, thus calling on us to glorify his power, wisdom and goodness."

Contrast with this view the view of Professor Bailey, in one of his charming essays in the volume entitled 'The Survival of the Unlike:' "We are now prepared to admit that this whole question of enemy and friend is a relative one, and does not depend upon right and wrong, but simply upon our own relationships to the given animals and plants. An insect which eats our potatoes is an enemy because we want the potatoes too; the insect has as much right to the potatoes as we have. He is pressed by the common necessity of maintaining himself, and there is every evidence that the potato was made as much for the insect as for the human kind. Dame Nature is quite as much interested in the insect as in man. 'What a pretty bug!' she exclaims; 'send him over to Smith's potato patch.' But a bug which eats this insect is beneficial; that is, he is beneficial to man, not to the insect. Thus everything in nature is a benefit to something and an injury to something; and every time that conditions of life are modified the relationships readjust themselves."

In these words Bailey, with his accustomed felicity, has expressed the situation admirably. Man is but one of the forms of life struggling for existence, at continual warfare with surrounding forms; but by virtue of his surpassing intelligence—itself as gradually evolved as have been the physical characteristics of any given species—he has overrun the earth, has accommodated himself to the most unnatural environments; he has dominated all other species in nature; he has turned to his own uses and encouraged or hastened the evolution of species useful to him or of useful qualities in such species; he has wiped out of existence certain inimical forms, and is gaining the control of others. He is the dominant type, and types whose existence and methods of life are opposed to his interests are being pushed to the wall. It is the culmination of a history which has many times repeated itself in past ages. The struggle of other forms of life to accommodate themselves to the conditions brought about by the rapid development of this dominant type is one the most interesting fields of study open to the biologist to-day. It would seem as if, in man's efforts to make the face of the earth his own, all the complicated elements of life were arrayed against him, and the great and ultimate result of the labor of the biologist in his study of the relations of the different forms of life and the laws which govern their development will be to bring about the absolute control of all other life by man. Thus it is not only the economic worker who looks for immediate results of a practical kind from his labor—the scientific agriculturist, the horticulturist, the economic zoologist, the medical bacteriologist—who should command the respect of even the practical-minded man, but the biologist in whatever field, however restricted it may be, whether he is working towards the understanding of broad principles and general laws, or whether in some narrow corner of research, he is accumulating material which will help ultimately to lead to wider understandings—all are working helpfully and practically towards the perfect well-being of the human race.

L. O. HOWARD.

WASHINGTON, D. C.

ANTI-FRICTION ALLOYS.

M. G. CHARPY, the well-known investigator in this field, publishes in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, for June, 1898, an extensive paper on the '*Travaux de la Commission des Alliages*,' of which the following are some of the main points:

The purpose of the investigation was largely that of finding a way of applying to alloys for bearings the tests previously deduced respecting relations of fusibility and other properties. General experience has shown that white alloys, customarily used for bearings in machinery, are much less frequently overheated than those made, as previously common, of bronze, while they are found also to reduce friction something like 20 per cent. In some instances the reported accidents with the two classes of metal are but $2\frac{1}{2}$ with the white metal as compared with 100 with the yellow in ordinary railroad work. Their wear is also but about 0.4 that of the bronze. So long, however, as a layer of oil remains in effective depth, on the rubbing surface, the coefficient of friction is substantially the same with all bearing metals. Flooded journals give immunity from friction, safety from heating and wear, and independence of the nature of the rubbing metals, except so far as their conductivity affects the removal of heat developed by friction.

Charpy gives an extensive table of the composition of various anti-friction alloys as reported by the authorities, including substantially all those reported by Dudley, Ledebur and Thurston. His own investigations are upon alloys of lead and antimony; of lead, tin and bismuth; of tin, copper and antimony; of lead, copper and antimony; of zinc, tin and antimony, and of copper, tin and lead; all of which are studied under compression and wear, and micrographically. Admirable prints are given of the micrographic development, and the 'stress-strain' diagrams, both for the binary and ternary alloys, are exhibited; the writer using the Thurston 'tri-axial' diagram, and the corresponding 'glyptic' representation in the solid, to illustrate his work.* The paper abounds in most interesting and helpful illustrations of these kinds.

He concludes substantially as follows:

(1) All these alloys, when fitted for use as anti-friction metal, exhibit the same general characteristics. They are made up of hard particles set in a soft and plastic alloy. The load is taken by the hard metal, while the friction is reduced by the comparatively low coefficient of friction and by the power which is given by the soft alloy of adapting the loaded surface to the position of the journal and to its deformations. The ternary alloys are thought better than the binary.

(2) The limits of practically useful alloys and mixtures are determined by this method of investigation and the best compositions are identified.

(3) The processes adopted are mainly graphic and micrographic, to ascertain whether the quality is suitable and the composition such as has been found desirable, and compressive tests to ascertain whether it has the needed power of resisting pressure, without serious deformation under ordinary conditions of use. 'Cooling curves' were found very helpful.

(4) Alloys of lead and antimony should contain between 15 and 25 per cent. antimony. Those containing more of this constituent are too hard and those containing more lead are too soft; the one will lead to brittleness and fracture, the other to crushing and cutting.

(5) The copper-tin-antimony alloy of best proportions is considered to be that containing Cu. 5.55; Sn. 83.33 and Sb. 11.11 by weight. It is strong and tough, corresponding with the alloys empirically selected for railroad journals by some railway authorities.

(6) The lead-tin-antimony alloys should contain between 15 and 90 per cent. tin, and

* See Transactions Am. Soc. Mech. Engrs., No. DCCLXXVII., Vol. XIX., 1898. Sauveur, in this country, has most extensively employed these methods of micrography in the work of his laboratory.

not above 15 or 18 per cent. of antimony. An alloy employed for metallic packing contains Pb. 80; Sn. 12; Sb. 8.

(7) The copper-lead-antimony alloy should not contain above 10 per cent. copper. One tested alloy of good character is Cu. 10; Sb. 25; Pb. 65. It has been used successfully on railway axles.

(8) The copper-tin-lead alloys are the usual bronzes of anti-friction metal makers. The lead is probably a necessary constituent for highest efficiency. They contain from 75 to 90 per cent. copper; 8 to 12.5 per cent. tin, and 0 to 15 per cent. lead. Fluxing with arsenic or phosphorus is usually advantageous, the amount found in such alloy averaging about 0.8 per cent.

R. H. T.

ANNUAL MEETING OF THE AMERICAN PSYCHOLOGICAL ASSOCIATION.

THE American Psychological Association held its seventh annual meeting at Columbia University, New York City, on December 28–30, 1898. Over fifty members were in attendance at the various sessions, this being the largest number at any meeting since the organization of the Association.

Owing to the number offered, the sessions were entirely given up to the reading and discussion of papers, but the members were present at the discussion before the American Society of Naturalists in 'Advances in Methods of Teaching,' being represented in the discussion by the President of the Association, Professor Münsterberg. Many of the members also attended the reception given by Professor and Mrs. Henry F. Osborn to the Affiliated Societies on Wednesday evening, and were present at the dinner of the Societies at the Hotel Savoy on Thursday evening. At the business meeting Professor John Dewey, of the University of Chicago, was elected President for the ensuing year; Dr. Livingston Farrand, of Columbia University, Secretary and Treasurer; and Professors J. McK. Cattell, of Columbia University, and H. N. Gardiner, of Smith College, members of the Council.

Besides other business transacted, there was appointed, on motion of Professor J. M. Baldwin, a Standing Committee of Psychological and Philosophical Terminology, consisting of Professors Münsterberg, Cattell, Sanford, Creighton, Royce, Minot and Baldwin. The duties of this committee are to recommend from time to time new terms and choice of alternative terms in psychology and philosophy; to recommend foreign equivalents for translation both into English and into foreign languages, and to keep the Association informed as to the growth of terminology in other departments, especially in neurology.

Professor J. McK. Cattell, Chairman of the Committee on Physical and Mental Tests, reported on the work of the Committee during the year and described the progress in this field in the different laboratories.

Professor Münsterberg, who presided at the meeting read his presidential address on Wednesday afternoon, taking as his subject 'Psychology and History.' Professor Münsterberg argued that the psychological and historical views of human life are necessarily in conflict; for the one the personality is a complex of elements and causally determined; for the other it is a unity and free. He held that claims of recent writers that psychology and history are two coordinated ways of dealing with the same problem are untenable; that the difference between the two is not methodological, but ontological. The materials are different. The material of psychology consists of objects which as such can be described and explained; the material of history consists of subjective will acts which can merely be interpreted and appreciated. Our interest in the two is different. The investigation

of the material of history brings us to a teleological system in which every will act is linked with every other will act and the general fact is not a causal law but a will relation.

The subject of the 'discussion' which followed the address of the President was 'The Relations of Will to Belief.' Professors James and Miller, who were to have taken part, were unavoidably detained from the meeting, and the discussion was carried on by Professors Ladd, Hibben, Caldwell and Armstrong. The first three speakers presented their views on the question, especial reference being paid to Professor James' essay, 'The Will to Believe,' while Professor Armstrong closed the debate with a historical summary of the subject.

Of the regular meetings of the Association for the reading of papers the first was on Wednesday morning and was opened by Mr. E. A. Kirkpatrick on 'The Development of Voluntary Movement.' After describing the case of a young child upon which he based his views, the speaker argued that movements, such as walking, that seem to be learned are in reality largely inherited, and that other nervous and muscular connections are less a matter of experience than is usually thought.

Professor E. B. Delabarre reported certain experiments made upon himself with Cannabis Indica, and attributed the effects to the hyperexcitability of the nervous system induced by the drug. There was a gradual increase in sensory, intellectual, emotional and motor activity, lasting about half the total duration of the main influence, and followed by a gradual decrease to normal or below.

Professor George T. Ladd read a paper in which he held that psychology was not making the progress in this country which might reasonably be expected, and held that the hindrances are, in part at least, matters of *personnel* in the body of professional psychologists. The particular hindrances mentioned by Professor Ladd were, in brief, the excessive scholastic spirit among psychologists and the consequent ignorance of the mental life of the great body of the people, the great number of publications by authors of insufficient training, the injury done to the science in the eyes of the laity by methods of discussion and controversy, the invasion of the commercial spirit and the maintenance of an improper attitude toward the other most closely allied sciences.

In a paper on 'Reason a Mode of Instinct,' Mr. Henry Rutgers Marshall argued that the objective mark of an instinct is that it determines in an organism typical reactions of biological significance to the organism; that opposition to instinct exhibits itself in variation from typical reaction, and is indicated by hesitancy and then choice. Reason is the psychic coincident of the physical process antecedent to choice. Variation and reasoning both appear as reactions of a part of a complex physical and psychical system. Variation is statable in terms of instinct, and hence reason itself must be looked upon as a mode of instinct, the observed opposition between the two being due to the complexity of the organic connections of the phenomena.

Professor Wesley Mills spoke on 'Animal Intelligence and Methods of Investigation,' emphasizing the importance of normal conditions in experimenting with lower animals, and objecting to the recent work of Dr. E. L. Thorndike, on the ground that he had violated this fundamental principle. The speaker further argued in general for greater caution in drawing conclusions from observations on animals.

Professor Mary Whiton Calkins read a technical paper on 'Psychological Classification,' dealing particularly with the attributes of sensation.

On Thursday morning, December 29th, the members of the American Physiological

Society who were meeting in New York were invited to hold a joint session with the Psychologists in the Psychological Laboratory in Schermerhorn Hall, for the reading, by members of both societies, of papers which might have a common interest. This joint meeting was successfully carried out, with President Chittenden, of the Physiologists, in the chair. Professor J. McK. Cattell opened the session with an exhibition of certain new instruments of his own designing, for the study of movement and fatigue, and a brief description of certain researches now in progress in the psychological laboratory at Columbia. Among other instruments was a spring ergometer, intended to replace the Mosso ergograph, and a dynamometer, in which the pressures are contiuually added and counted, making the study of muscular fatigue and the effect of mental conditions on fatigue possible without elaborate apparatus.

The other psychological papers presented at this session were by Professors Münsterberg, Patrick and Scripture. Professor Münsterberg spoke on the 'Physiological Basis of Mental Life,' pointing out certain fundamental objections to current physiological theories of brain processes, and suggesting several modifications which would account for more of the factors in psychophysiological activity than is now the case.

Professor G. T. W. Patrick reported experiments on tastes and odors made in the laboratory of the University of Iowa upon a subject with complete congenital anosenia. Among other conclusions he drew the following: That what commonly passes for taste sensations, so far as their discriminative or intellectual value is concerned, is the composite result of the mingling of sensations of smell, touch, temperature, sight and taste; the latter, however, playing little or no part in the discrimination of our common foods and drinks. Taste sensations furnish rather the emotional element in the total conscious effect.

Dr. E. W. Scripture gave a lantern exhibition of his methods of demonstrating the the physiology and psychology of color, and by special invitation Professor Ogden N. Rood, of Columbia University, demonstrated his 'Flicker Photometer.'

Physiological papers were read by Professor F. S. Lee on 'The Nature of Muscle Fatigue,' by Professor G. C. Huber on the 'Innervation of the Intracranial Vessels,' by Professor C. F. Hodge on 'Possible Amœboid Movements of the Dendritic Processes of Cortical Nerve-cells' and by Professor G. W. Fitz on 'A New Chronoscope.'

At the meeting on Friday morning Mr. J. E. Lough reported experiments made at Wellesley College, on the changes in rate of respiration during mental activity started by visual stimuli. There was in every case an increase in the rate during stimulation and a return to the normal afterward, the amount of the increase produced by a given stimulus corresponding in a general way to the degree of mental activity produced.

Dr. Robert MacDougall described researches now in progress in the laboratory at Harvard, and Dr. E. W. Scripture reported the work at Yale. Among other investigations Dr. Scripture reported interesting results from passing alternating currents of high frequency through the human body, producing practical anæsthesia and analgesia to touch and cold, though apparently not to heat. The speaker called attention to the possible value of this method in producing analgesia for surgical purposes. Dr. J. P. Hylan gave an account of the work in the laboratory of the University of Illinois, and was followed by Dr. G. V. Dearborn, who described experiments on recognition under objective reversal, using chance blots of ink on white cards, arranged in series of ten and reversed in each of the four quadrants and in the mirror, and

always in a plane at right angles to the visual axis. He found that an object is recognized more readily when inverted than when in either of the two intermediate positions, and more readily also than in the erect mirror reversal or in that position inverted.

Dr. Arthur MacDonald reported further measurements of pain and gave tables and results. Two purely philosophical papers were presented, one by Professor W. A. Hammond on the theory of the will in Aristotle's Ethics, and the other by Professor W. G. Everett on 'Ethical Scepticism.' These papers closed the morning session. In the afternoon Professor W. Caldwell read an appreciative criticism of Professor J. Mark Baldwin's recent work on Social and Ethical Interpretation. A paper on the genetic determination of the self, which had been announced by Professor Baldwin, he was forced to abandon on account of illness.

In a 'Study of Geometrical Illusions,' Professor Charles H. Judd upheld the thesis that the underestimation of acute angles and overestimation of obtuse angles, which is a common feature of many illusions, is not a fundamental fact, but is to be explained as due to the false estimation of the length of the sides of the angles.

Professor Margaret F. Washburn spoke on 'Subjective Colors and the After Image,' and Professor Ladd closed the meeting with a description of a new color illusion.

Livingston Farrand.

SCIENTIFIC BOOKS.

The New Maryland Geological Survey. Volume I., 1897. Volume II., 1898. Johns Hopkins Press.

The plan and the organization of the Maryland Geological Survey are set forth in the introduction to the first volume of the reports. In many respects they present admirable examples of common sense in scientific work. The business of a State Survey, if successful, must be conducted so that it nets the people a fair return for their money. It may neither soar to abstruse and doubtfully profitable speculation nor sink to politics for spoils only. Failing to avoid one or the other unbusiness-like extreme, many State Surveys have died. The Maryland Survey appears to have struck a course between Scylla and Charybdis.

According to the organic law the name is the State Geological and Economic Survey. The control is in the hands of a commission, consisting of the Governor and Comptroller of the State and the presidents of two principal educational institutions—of Johns Hopkins University and the Maryland Agricultural College. The commissioners shall appoint as superintendent a geologist of established reputation, who shall nominate for appointment by them such assistants as they deem necessary; and they shall determine compensation of employees and may remove them. The objects of the Survey are defined in six articles, of which three relate to appropriate investigations having practical bearing, two give authority to publish maps and reports, and the sixth confers special authority to consider 'such other scientific and economic questions as in the judgment of the commissioners shall be deemed of value to the people of the State.' Among other sections is one appropriating $10,000 per annum for the purpose of executing the provisions of the act. This section must be repealed before the appropriations for the support of the Survey can cease.

By this law a board of commissioners, which is equally divided between the educational and executive or political leaders of the State, is given unrestricted authority to carry on appropriate observations for the benefit of the people. The scope is unlimited, their power is absolute, their responsibility is direct.

The Commission organized the Survey to insure practical and thorough work. Professor Wm. B. Clark, of Johns Hopkins, was appointed State Geologist. It was resolved that there should be no salaried officers, all services to be paid at per diem rates for the time employed.

The scope of the Survey was determined to be economic and educational. The economic character was sufficiently prescribed by the law;

but an educational purpose has rarely, if ever, been so frankly assumed by a State Survey. The necessity to enlighten the general public as to the ends of a geological survey, though well understood, is generally stated in an aside.

The position taken by the Maryland Survey gives it strength and a broader opportunity. It will be thought by many who know him that President Gilman has exercised a controlling influence in this as in other wise decisions of the Board.

Strong in its close relations with the Maryland Agricultural College and Johns Hopkins University, the Maryland Survey has sought still further to strengthen itself by cooperation with the scientific bureaus of the National Government. The Agricultural Department, the Weather Bureau and the Geological Survey have met the State Survey's advances cordially, and the work of Professor Clark and his colleagues is supplemented by that of members of the several National organizations.

Maryland undertakes no new task in organizing this economic survey. Exploration and mapping have been in progress since the earliest days of settlement and thus cover more than two centuries and a half. Logically planned, the reports open with an historical account of this progress, which begins with the voyage of Captain John Smith in 1608. Reading the early accounts of the region about the Chesapeake one is reminded of recent descriptions of Alaska or the Phillipines. The degree of knowledge expressed is similar. In 1635 it was written of Maryland :

"The Countrey is generally plaine and even, and yet hath some pritty small hills and risings ; It's full of Rivers and Creekes and hath store of Springs and smaller Brookes."

"The Mineralls have not yet beene much searched after, yet there is discovered Iron Oare ; and Earth fitt to make Allum, *Terra lemnia*, and a red soile like Bolearmonicke, with sundry other sorts of Mineralls, which wee have not yet beene able to make any tryall of * * * and to conclude, there is nothing that can be reasonably expected in a place lying in the latitude which this doth, but you shall either find it here to grow naturally ; or Industry, and good husbandry will produce it."

Modern events were perhaps prophesied in the note on Herman's map of Maryland (1670) :

"Certain it is that as the Spaniard is possessed of great Store of Mineralls at the other side of these mountaines the same Treasures they may in process of time afford also to us here on this side when occupyed which is Recomended to Posterity to Remember."

The first geological survey of Maryland was authorized by law in 1834. It is interesting to compare that act of the Assembly with the act passed with the same object sixty-two years later. The Act of 1834 authorizes the Governor and Council to appoint an Engineer and a Geologist at salaries of $2,000 each ; it prescribes the duties of the engineer and even more precisely those of the geologist. The latter shall "make a complete and minute geological survey of the whole State, commencing with that portion which belongs to the Tertiary order of geological formations, and with the southern division thereof, and progressing regularly with the course of the waters of the Potomac and Chesapeake through that region, and thence through the other subdivisions of the State, with as much expedition and despatch as may be consistent with minuteness and accuracy."

By a special section of the act the Geologist is instructed to analyze mineral substances or soils left at his office or residence by any citizen of the State ; he is to report all 'remarkable discoveries," a command whose phraseology sufficiently indicates the common understanding of a survey's raison d'être. The expenses of the Engineer and Geologist are to be paid, "so far as they may be deemed just, equitable and proper, to an amount not exceeding one thousand dollars per annum. But the official services of these gentlemen shall cease at the end of one year, unless the act be re-enacted by the next Legislature.

In strong contrast with the petty control thus assumed by the Assembly of 1834 is the freedom of action granted in 1896, and not less striking is the personal tone of the former act when compared with the impersonal character of the latter one. The one might have been entitled : An act to hamper a State Geologist ; the other has created a State Survey.

The historical account is brought down to

the date of writing by sketches of the work of all existing institutions which are contributing to a knowledge of Maryland's resources. The valuable work of the late Professor G. H. Williams is appropriately set forth at length. The sketch closes with lists of the surveys and maps relating to Maryland made by the U. S. Coast and Geodetic Survey and the U. S. Geological Survey, and these lists are supplemented by excellent index maps of the State, showing the triangulation and the arrangement of map sheets.

Following this historical article by Professor Clark is a second, on the present knowledge of the physical features of Maryland, embracing an account of the physiography, geology and mineral resources. Of this it need only be said that it is concise, complete and accurate, so far as the data now available permit. This report frankly recognizes the existing information concerning the State as the seed from which future knowledge must grow. An excellent geologic map lithographed by Hoen & Co. illustrates the article.

A bibliography and account of cartography of Maryland, by Dr. E. B. Matthews, logically completes the historical portion of the volume and constitutes an important work of reference.

An earnest of the important results which the Maryland Survey is to accomplish is contained in the article by L. A. Bauer on a magnetic survey of the State. Including an account of the history and objects of magnetic surveys, this preliminary report is of broad general interest. Declination and dip of the needle and intensity of the magnetic forces are defined. A history of magnetic surveys and an account of methods follow. There is an extended account of variations of magnetic declination. The distribution of the declination in Maryland is described and illustrated by a map. And, finally, the economic value of the work is set forth in a discussion of the establishment of surveyor's meridian lines.

The second volume of the Maryland Survey reports, when compared with the first, is a demonstration of the wisdom of doing one thing well and the next thing better. Both volumes are superior in utility and appearance to any State report previously issued. That the Maryland Survey has already won the confidence of the people and the Legislature is shown by the appropriations of $5,000 to promote topographic surveys and $10,000 to conduct investigations for betterment in highways. These sums, added to the appropriation of $10,000 for geology, place in the hands of the Geological Survey Commission annually $25,000 to be spent for the benefit of the people of the State. That it will be expended in securing authoritative information appears from the contents of the second report.

Dr. G. P. Merrill, an authority on building stones, contributes an article on the physical, chemical and economic properties of building stones in general, with special reference to the needs of the Maryland industry. This article is of general interest, as furnishing information of primary importance to capitalists, quarrymen and users of stone. It is followed by an exhaustive description by Dr. Mathews of the quarry products of Maryland considered with reference to their qualities, accessibility and adaptation. The subject is treated in detail, being classified under the headings: 'Granites and Gneisses,' 'Marbles and Limestones,' 'Sandstones,' 'Slate,' and the 'Building Stone Trade,' and further subclassified by localities throughout the State. The author personally examined each quarry and made his observations with expert knowledge. The report is very beautifully illustrated, not only by the usual photographs of quarries, but also by photomicrographs of the rocks and by full-page colored heliotypes which represent the texture and color of the stone as they appear in a smoothed specimen.

The appropriation of large sums to prepare a topographic map of Maryland affords a reason for stating the objects of such a map, and such a statement might suffice simply as an explanation. But to meet the educational purpose of the Maryland Survey more is required, and this something more is supplied by Mr. Gannett's article on the aims and methods of cartography with especial reference to topographic maps. The methods now in use in extensive surveys were developed by Mr. Gannett and his assistants and are characteristically original.

In their present development they constitute the most practical methods known, because they are the most economic while they are also adequately accurate.

The succeeding article by Dr. Mathews on 'Maps and Map Makers of Maryland' is of much historic interest. Dr. Mathews has ably assisted Professor Clark in his effort to make the Survey of Maryland a success, and to them both, as well as to the Geological Commission, belongs the credit of raising the standard of economic surveys to a grade that few can reach and none have surpassed.

BAILEY WILLIS.

La vie sur les hauts plateaux. Par le PROFESSOR A. L. HERRERA et le DR. D. VERGARA LOPE. Published by A. L. Herrera, Museo Nacional, Mexico. 1899. 4to. Pp. 786. Price, $6.

This remarkable work won the Hodgkins prize of the Smithsonian Institution, and now, translated from Spanish into French, is published in beautiful form through the munificence of President Diaz, of Mexico, to whom it is appropriately dedicated.

Professor Herrera, as the best type of a man of science, is an honor to our sister republic. His epoch-making ideas on the subject of museums have been very influential in France.

The present important volume is on matters for whose investigation the authors are most advantageously situated, having lived that life on the high plateaux of which they so ably treat.

The book opens with a chapter on the relief of both continents; the distribution of the great plateaux; their relations, ethnographic and hygienic. Chapter II. is on the vertical distribution of vegetable life and the phenomena of adaptation in the species of high altitudes. This is particularly rich in regard to the flora of Mexico and especially the Valley of Mexico. The action of the increased intensity of the sunlight is exhaustively studied.

Chapter III. devotes two hundred pages to the vertical distribution of animals, with the phenomena of adaptation, and in particular the influence of rarefied air. A study is made of mountain sickness as exhibited by animals.

Chapter IV. passes to the vertical distribution of mankind. Chapter V. is devoted to anthropometry and physiology of man at high altitudes. Worthy of note is the part on digestion, illustrated by considerations on the food supply of the City of Mexico. Chapter VI. is very short, treating of atmospheric pressure in geologic epochs and its supposed influence on organic evolution. Chapter VII. is largely taken up with experiments on the action of rarefied air. Chapter VIII. is on combustion and fermentation at high altitudes. Book II., applications, begins with Chapter IX., on typhus and scrofula at high altitudes. But of intense interest, of universal importance, is the matter of Chapter X., on the treatment of tuberculosis by altitude.

Statistics prove that the maximum of mortality from this dread destroyer pertains to low regions, the minimum to high. In more than 60 cases the curve of mortality rises as that of altitude descends.

In Mexico, even among the poor and the soldiers, there are less deaths from tuberculosis than in the low regions of Europe. For a thousand victims in regions below 500 meters there are only 255 in regions above 500. In Mexico out of 100 persons the parents of 3 will have died of tuberculosis; in Lima the parents of 18.

A residence at high altitudes is indicated for persons with hereditary or any other predisposition toward tuberculosis; for persons with defective chest-conformation or respiratory capacity, or in whom inflammatory affections have been incompletely cured. Even for animals the data show at high altitudes a certain immunity against tuberculosis.

In 1885 of 73,000 cattle killed at the general abattoir of the City of Mexico only 45 were tuberculous, while in England the proportion rises as high as 20 in 100

It is known, say our authors, that in tuberculosis the climate of high altitudes, even for those far advanced, prolongs life. What is it, then, that can diminish the number of cases or help those already attacked? Our authors attack this momentous question in the true spirit of experimental science. The illumination by the solar rays attains its maximum at high altitudes, and experiment proves that light

kills the bacilli and their spores with incredible rapidity. The dryness and cold also work against the existence of microbes.

But how can the rarefied air influence favorably pulmonary tuberculosis? After prolonged experimental study our authors sum up their results in certain theorems, which are discussed separately: (I.) Lessening pressure increases the circulation of air in the lungs, dilates them and obliges torpid parts to functionize. (II.) Lessening pressure determines a greater quantity of blood to the lungs. (III.) Lessening pressure, dilating the lungs, permits a uniform distribution of blood, makes regular its circulation and thus combats congestion. (IV.) Lessening pressure diminishes intrapulmonary tension in general and in particular intravascular tension. (V.) Augumentation of red globules and white globules. (VI.) Desiccation of mucous surfaces. The favoring of evaporation.

Numerous experiments on animals were followed by the actual treatment of tuberculosis by rarefied air, diminution of pressure. The results were highly encouraging and remarkable. Of the 13 healthy persons and numerous consumptives submitted to the action of rarefied air not one experienced the alarming symptoms described by P. Bert (Pression barométrique, p. 750). The experiments of Paul Bert having been credited, put a stop to all progress in these matters, and the whole world is indebted to Herrera and Lope for removing the embargo and smashing the tabu.

Of 13 cases of pulmonary tuberculosis treated by baths of rarefied air only one lost weight, one remained stationary, eleven increased most notably in weight, one increasing 300 gr. each day, one increasing 28 gr. each day during 4 months of treatment.

Our authors hold that the acclimation of plants, animals and man to the atmospheric conditions of high altitudes is rapid and in general perfect, without the slightest loss of vigor.

The vegetable kingdom reaches its maximum at high altitudes. As for mere size we need only mention the great tree of Tula and the tree of Montezuma. Any limitation is question of temperature, not atmospheric density. Species ascend the summits as they approach the equator. This is a pregnant hint for scientific agriculture. The more intense light of the altitudes, as also the dryness and decreased pressure, influence favorably the formation of chlorophyl, the decomposition of carbonic acid, the formation of amidon, the movement of protoplasm, the multiplication of epidermic cells, the force of transpiration, the absorption of oxygen.

As for animals, the fact that many species emigrate periodically to high altitudes and flourish there proves that often acclimation is exceedingly quick. Mammals are subject to 'mal des montagnes' and then must undergo a period of acclimation more or less troublesome. The symptoms are analogous to those in man. But the result is perfect adaptation. Longevity is not decreased, nor fecundity, nor secretions (*e. g.* milk).

In the blood the number of red globules augments with the altitude. There is an exact proportion between this number and the barometric pressure of the locality. This is so little known that in Mexico reputable physicians have declared patients not suffering from anemia despite most evident symptons, simply because microscopic examination of the blood disclosed the number of the globules considered as normal in Europe! The tension of the blood diminishes with the altitude. On the other hand, the intensity of intra-organic combustion, the temperature, the colorification is exactly the same for inhabitants of the City of Mexico, at an elevation of 7,350 feet, as for man at the low European levels.

This whole book is so unexpectedly rich in scientific contributions of the most momentous practical importance that no one working in any of the subjects touched can afford to be without it, and our sister republic deserves to be publicly congratulated on its appearance.

George Bruce Halsted.

Austin, Texas.

Books Received.

A History of Physics. Florian Cajori. New York and London, The Macmillan Company. 1899. Pp. viii + 322. $1.60.

The Microscopy of Drinking Water. George Chandler Whipple. New York, John Wiley & Sons; London, Chapman & Hall, Ltd. 1899. Pp. xii + 300 and 19 plates.

Who's Who, 1899? Edited by DOUGLAS SLADEN. London, Adam and Charles Black; New York, The Macmillan Company. 1899. Pp. xx + 1014. $1.75.

Laboratory Manual in Astronomy. MARY E. BYRD. Boston, Ginn & Co. 1899. Pp. ix + 273.

Experimental Morphology. Part II. Effect of Chemical and Physical Agents on Growth. CHARLES BENEDICT DAVENPORT. New York and London, The Macmillan Company. 1899. Pp. xviii + 508.

SCIENTIFIC JOURNALS AND ARTICLES.

American Chemical Journal, February: 'On the Constitution of the Salts of Imido-Ethers and other Carbimide Derivatives,' by Julius Stieglitz. 'On the Hydrochlorides of Carbophenylimid Derivatives,' by H. N. McCoy. 'On the Solubility of Argentic Bromide and Chloride in Solutions of Sodic Thiosulphate,' by T. W. Richards and H. B. Faber. From a study of the solubility and effect upon the freezing points of solutions caused by these salts certain conclusions have been drawn as to the probable nature of the substances present in solution. 'Note on the Spectra of Hydrogen,' by T. W. Richards. The author considers the presence of the red spectrum to be due to a breaking-down of water vapor forming atomic hydrogen, which gives the red spectrum. If the gas is perfectly dry the white spectrum alone is obtained. J. E. GILPIN.

THE first number of *Bird Lore*, edited by Mr. F. M. Chapman, and devoted to popular ornithology, has just appeared. As the official organ of the Audubon Society, and in appealing to young readers as well as old, *Bird Lore* essays to cover a new field. The frontispiece is a view of John Burroughs at 'Slab Sides,' and the first article, 'In Warbler Time,' is from his pen. There are two articles illustrated by photographs from life, by Dr. T. S. Roberts and H. W. Menke; Miss Isabel Eaton has a department for teachers and students, and Miss Florence A. Merriam one for young observers; Notes, Reviews and Editorials follow; while the Audubon Department, edited by Mrs. Mabel Osgood Wright, concludes the number.

WE have received the first number of *The School World*, published in Great Britain, by Messrs. Macmillan & Co., and addressed especially to teachers in the secondary schools. The first number presents an interesting table of contents including articles on 'The Teaching of Algebra,' by Professor G. B. Mathews, F.R.S.; 'Physical Observations of Brain Conditions of Boys and Girls in Schools,' by Dr. Francis Warner; 'Bimanual Training in Schools,' by Mr. H. Bloomfield Barry; 'Elementary Experimental Science,' by Professor R. A. Gregory and Mr. A. T. Simmons; and 'Current Geographical Topics,' by Dr. A. J. Herbertson.

THE Annual Report of the Director of the Field Columbian Museum for 1897–98 notes good progress, particularly in the Departments of Anthropology, Geology and Botany. Two of Mr. Akeley's fine groups have been added to the exhibition series, one of the Oryx and one of Waller's Gazelle, the latter very striking from the pose of the principal figure and from the extreme length of neck and limbs obtained by these animals. One of the plates in the report shows the large model of the moon recently noticed in SCIENCE. The Director notes that special attention has been given to what he aptly terms the 'highly important but uninteresting and endless labor' of cataloguing, inventorying and labelling

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SOCIETIES AND ACADEMIES.

THE BIOLOGICAL SOCIETY OF WASHINGTON.

THE 300th regular meeting of the Biological Society of Washington was held January 14, 1899, President Frederick V. Coville in the chair. Brief notes were presented by the following members: Ashmead, Bailey, Pollard, Erwin F. Smith, Chesnut and Cook. Mr. Ashmead exhibited specimens of a very rare South American wasp (*Chirodamus*), the type of which was secured by Charles Darwin during the voyage of the 'Beagle.' The new specimens were secured by the U. S. Fish Commission and belong to the National Museum.

Mr. Vernon Bailey described a case of protective coloration in *Ochotona*, a coney native to the mountains of California. One of the broken pieces of the rocks among which the animals live was shown in comparison with a stuffed specimen. Mr. Chesnut submitted photographs and fruits of the California Laurel

(*Umbellularia californica*), a small tree of the olive family. A volatile oil is distilled from the leaves and used for medicinal purposes, while the fruits are eaten by the Indians after being roasted to destroy an acrid principle which they contain.

In the regular program Mr. C. L. Marlatt explained the difficulty and confusion which has appeared in connection with previous attempts at designating numerically the broods of the Seventeen-Year Locust, or Periodical Cicada. This insect presents two distinct races, or subspecies, the more southern of which has a thirteen-year period. Mr. Marlatt proposes to use the Roman numerals from I to XVII for the seventeen-year broods and then continue from XVIII to XXX for the thirteen-year series, thus providing a fixed designation for every possible brood. Preceding nomenclatures of the subject were compared with the new suggestions by means of charts. The paper was discussed by Messrs. Howard, Lucas, Gill, Waite, Ashmead and Cook.

Dr. E. A. de Schweinitz explained the practical working of the serum treatment for swine plague and hog cholera. In the previous season (1897) about 200 animals were treated, with a loss of about 20 per cent., while of the recorded cases of uninoculated animals about 80 per cent. died. During the past season the treatment was given to about 2,000, with a loss of about 23 per cent., while of 4,000 untreated about 40 per cent. died. The slightly greater percentage of loss this season is explained by the fact that the conditions of the experiment were not as carefully controlled. The difficulty of diagnosis renders it desirable to use a mixture of the serums prepared for the two diseases.

Dr. Erwin F. Smith discussed 'The Effect of Acid Media on the Growth of Certain Plant Parasites.' Extended experiments with several bacterial diseases of plants demonstrate that some species of these are exceedingly susceptible to an excess of acid in the culture medium. The very slow progress of some such diseases was explained by the fact that they are limited at first to the vascular system, the fluids of which are alkaline, while those of the parenchyma are acid. Some of the germs refused, in fact, to grow at all in the media prepared with the juices of their own host-plants, until the acidity had been artifically neutralized, while in others growth was greatly retarded. A chart was exhibited showing the comparative reactions of the various species studied, with reference to a definite scale of acidity and alkalinity.

O. F. Cook,
Corresponding Secretary.

MEETING OF THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

The January meeting of the New York Section of the American Chemical Society was held on Friday evening, the 13th ult., in the Assembly Hall of the Chemists' Club, 108 West 55th street, Dr. Wm. McMurtrie presiding.

An arrangement for holding the meetings of the Society regularly in the club building was announced and ratified by unanimous vote. Reports were made showing that the funds contributed for the expenses of the midwinter meeting had been sufficient; that the library had been moved to the club rooms, where it was undergoing classification and arrangement, and that the resident membership had reached one hundred, and the non-resident nearly, if not quite, as many more.

The following papers were read: 'Determination of the Bromine Absorption of Fats,' P. C. McIlhiney; 'Indicators,' John Waddell; 'Exhibition of Apparatus for Washing Precipitates,' etc., W. D. Horne.

Mr. McIlhiney recommends the bromine number instead of the iodine number for identifying oils and fats, on account of the greater rapidity of reaction, greater stability of the bromine-carbon tetrachloride solution both before and during use, and the want of differentiation by iodine, between addition and substitution compounds in the reaction.

Mr. Waddell showed some very pretty experiments illustrating the behavior of indicators, and explanatory of their adaptability to acid or alkaline reaction, according to their respective constitution.

Phenolphthalein, a weak acid, reacts red by dissociation in presence of a strong alkali; in presence of ammonia and alcohol the reaction

may be restrained and again developed by addition of water.

Methyl orange, cyanine and coralline were similarly demonstrated.

A letter was read from the General Secretary stating that "at the closing session of the mid-winter meeting at Columbia University, December 28th, by unanimous vote, the cordial thanks of the Society were extended to the New York Section for the bountiful hospitalities of the Section, which were so heartily enjoyed by the members of the Society during the eighteenth general meeting."

DURAND WOODMAN,
Secretary.

DISCUSSION AND CORRESPONDENCE.

REPLY TO CRITICS.

SUPPOSE a house just finished is empty; suppose that it is painted inside and out so as to conceal from vision everything but the paint. Suppose I come upon such a house for the first time and consider it a body of paint, for paint is the only thing that appears at first. In time I discover that it is made of bricks. At first it had the appearance of paint; now it has the appearance of paint and bricks. After further investigation I find that it is partly of wood, for wood appears in its structure. Now, I conclude that it is paint, bricks and wood. By further investigation I find that it is composed partly of iron. Now, I consider it as paint, bricks, wood and iron. Then I might investigate paint, bricks, wood and iron to discover their chemical constitution and the biological history of wood, and new facts would appear. I might go on indefinitely to show how new things are discovered in the building, both in structure and in purpose, and the new things discovered will appear to me. Those already mentioned are enough for this illustration.

Common sense says that paint is paint. The metaphysician says that paint is appearance; that there is no paint as paint, or at least all we know about it is appearance. The same may be said with regard to the bricks. Common sense says bricks are bricks, whether they appear or not; the metaphysician says the bricks are only appearances. Common sense says there is wood, whether it appears or not; the metaphysician says no, it is only appearance. When we discover the iron, common sense says there is iron in this structure, whether it appears or not; the metaphysician says no, there is only appearance.

Let us get a learned name for appearance. Let us call appearance 'phenomenon,' for that is the Greek word meaning appearance. Now, common sense says that paint, bricks, wood and iron are paint, bricks, wood and iron, respectively, and that appearance is appearance; but our metaphysician says that all of these things are only appearance and we call appearances phenomena; therefore, this house, with all its appearance, is only a concatenation of phenomena. Ofttimes it is asserted that the world is a phenomenal world. Those who make this assertion believe that the world is only appearance. Common sense says that all things of the world exist and manifest themselves by appearance, but that they exist whether they manifest themselves or not. Metaphysic says that the things of the world do not exist as they appear, but that their substrates exist, and that these substrates manifest properties which are not the things themselves. The properties are only illusions—there is no iron, but there is a substrate of iron which manifests certain attributes which are illusions.

In modern times there are two ways in which these supposed illusions are explained. In one way the attempt is made to show that the substrate of things is psychosis or abstract mind; the other is the attempt to explain that the substrate is force or motion. Thus, metaphysicians may be classified as idealists and not materialists.

Common sense says that we may know a body imperfectly and by investigation cognize more and more about it, and, however, simple a body it may be, we may, by investigation, learn very much about it and still not know all.

The idealist says this is true, but by further investigation everything will turn into appearance until we resolve the body into a substrate, and its substrate will be found to be psychosis, which is timeless and spaceless.

The materialists say we know more and more about a body until we resolve it into motion or force, some holding that force creates motion, others that force is a mode of motion; so that

this school is divided into two classes—those who believe force to be the substrate of bodies, and those who believe motion to be the substrate of bodies. Those who believe that force is a substrate believe that force is attraction and repulsion; those who believe that motion is the substrate believe that attraction can be resolved into repulsion and hence that force is a mode of motion.

The idealist believes also that force is attraction and repulsion, for this seems necessary to his doctrine that psychosis is the substrate of phenomena.

In SCIENCE for January 27th two eminent men review my little book on 'Truth and Error.' One seems to be an idealist, for he is marked with the paint-pot of this philosophy, though he repudiates it. The other seems to be a materialist as the term was defined in the book. Of course, the terms used do not characterize their theology or their religion, but only their philosophy. The philosophy of the second writer would be characterized better if it were called dynamism; but the popular designation is materialism, and the use of the term dynamism would probably offend Mr. Ward. Mr. Ward is the most illustrious champion of this philosophy in America, and he has written a work on this subject, entitled 'Dynamic Sociology,' which is dynamic philosophy applied to sociology.

During the last decade of this century great activity has been developed in scientific psychology. The new science is confronted with this problem, which is solved in the way I have tried to indicate. All psychologists are drawn into a whirlpool of disputation, and those scientific men engaged in other departments of research often drift into it.

Usually the idealist sneers at a philosophy of science, for 'science deals only with phenomena,' mere appearance—and philosophy deals with the substrate, the thing in itself—psychosis. Dynamism always advocates a mechanical philosophy when its votaries attempt to philosophize, as Ward has done and as Spencer did before him.

In the same number of SCIENCE to which reference has been made there is a review of Mivart's book, probably from the standpoint of a dynamist, but perhaps from the standpoint of an idealist, for this philosophy is of many kinds. Notwithstanding the denial by the idealist of a possibility of a philosophy other than idealism, the warfare between the two philosophies is rife, and at the present day is the subject of disputation, as evolution was the subject a few years ago. Every new publication on the broader aspect of science takes up the gauntlet for one or another of these subjects. Now, I believe that these metaphysical philosophies are mutually destructive, like the cats of whom Mr. Brooks speaks; yet I believe that both contain an element of truth, and that the Kantian doctrine of antinomies, which was elaborated into a doctrine of contradictories by Hegel, is a fallacious logic.

Of course, I do not expect to please the idealist or the dynamist, nor do I expect to kindle the love of those who believe that all philosophizing is in vain, but of this class there are comparatively few. There are engaged in scientific research many men who cultivate a special field and who attempt to harmonize opinions only within that field. There are others who survey larger fields and make wider attempts to arrive at congruities, and there are still others who attempt to make all fundamental doctrines of science congruous, and this is what I have attempted to do in my book.

Consciousness and choice, as the fundamental judgment, certainly inhere in animals, and I have proposed as an hypothesis worthy of consideration that all particles have these elements of judgment. Besides animals there are other bodies in the universe; these are molecules, stars, rocks and plants. In the science of chemistry it is universally recognized that there is a phenomenon in chemical reaction which is called affinity and which eminent chemists believe to be choice. The late T. Sterry Hunt was an advocate of this doctrine. If there is choice of one particle for another there must be consciousness, and this is the doctrine held by Hunt. I merely cite the example and affirm that there are many such chemists. Chemistry is not my special field of investigation, but the doctrine which I learned from chemists and which has been advocated by many others, especially physicists, like Herschel, is taken by

me as an hypothesis to be applied in the new science of psychology, which I do try to cultivate.

I have already set forth that choice is the relational element which corresponds to the essential element—consciousness. Now, by this hypothesis, consciousness inheres in every particle of matter. It does not inhere in bodies themselves as such, but only in their several particles, unless they are animals, for both require an organization for the faculties of mind in order that they should have judgments and concepts. The faculties of mind do not exist in molecules, stars, rocks and plants as bodies. The element of consciousness, together with the element of choice as inference, is exhibited only in the particles of what I call mechanical bodies to distinguish them from animal bodies.

In molecules we have the affinity of the particles, but the particles themselves are incorporated only as numbers. The many particles constitute the organ of the one molecule. Hence chemistry is the science of kinds, but of natural kinds as distinguished from conventional kinds employed by man in the arts. In the molecules we discover a discrete degree of incorporation and organization, because in nature incorporation or evolution is accomplished in stages by properties.

The molecule has not consciousness as a body or kind, but it has consciousness in its several particles. Here we must understand the distinction between organization and incorporation. When we consider incorporation we consider the one body; when we consider organization we consider the many particles of the one body. Organization and incorporation are thus reciprocals. When we consider organization we consider the relation of parts to one another; when we consider incorporation we consider the whole body. The incorporation of a molecule is by the affinity of its particles, and the particles are the organs of the molecule, and they make of the molecule a new kind of substance. Modern chemistry recognizes this fact, for it is taught that when molecules combine with molecules to make molecules in a higher order or kind, the combination is of ultimate particles and not a mere juxtaposition of constituent molecules. So I interpret the teachings of the new chemistry. For example, solution is now held to be chemical action and to involve affinity, and is not a mere mechanical mixture of the matter held in solution. This molecule is a body with organs; as particles they perform the function of incorporation for the molecule.

The nature of incorporation and organization may be illustrated. A hundred persons may meet to organize themselves into a society. They organize by first electing a president, the executive officer who governs the body; then they elect a secretary, who is the memory of the body; they may elect a treasurer and other officers; I need not extend the subject beyond the president, secretary and treasurer. Now, a group of members constitute a body organized with a president and secretary. In this manner the hundred individuals become one body. In the same manner in every body of nature—molecules, stars, rocks, trees or animals—there is an incorporation which is effected by organization.

The particles of the society are its individual members; every one has consciousness, but the body itself has no consciousness; so the molecule has consciousness in its particles, but there is no consciousness by the molecule. In nature all the particles of a body are organized; but in social bodies all the members become the body, and every one is an organ of the body.

In stars, kinds of molecules are incorporated into forms as globes; the kinds thus become the organs of form. Here we have another discrete degree of incorporation or evolution. While the forms as bodies or stars are considered when we consider the incorporation, the parts of the body as molecules are considered when we consider its organization. In the stars there are no organs of mind, but there are organs of form which are molecules, and in the molecules there are organs of kind which are the particles. So the star body has consciousness and choice only in its ultimate particles, for it has as a body no organs of mind.

In rocks, forms are incorporated as forces in which stresses and strains are produced. The forms are organs of force. Here we have a third discrete degree of incorporation and organization. To see how this incorporation is

effected by organization we must consider the spheres of geonomy. They are the centrosphere, lithosphere, hydrosphere, atmosphere and ethrosphere. These are organs of stress and strain which cooperate with one another in producing a succession of changes. Strains are set up in one geonomic sphere which produce stresses in another, and thus we have organs of force. These organs of force are forms, so that incorporation implies organization, and organization implies incorporation. Here we have no organs of mind; but we have organs of force, which are forms, and organs of forms, which are kinds, and organs of kinds, which are ultimate particles.

Plants are incorporated as causations in which an antecedent is followed by a like consequent. The child, or consequent, is like the parent, or antecedent, thus developing heredity. The forces now are the organs of causation, and we have a fourth discrete degree of incorporation and organization. Still, there are no organs of mind, but only organs of force. The forces have organs of form, the forms have organs of kind, and the kinds have organs of particles; consciousness and choice, therefore, still inhere only in the particles.

Animal bodies are incorporated as minds, and the organs of minds are causations. Here we have a fifth degree of incorporation and also of organization. With bodies incorporated with organs of mind, which are causations, and with bodies of causation incorporated with organs, which are forces, and with forces incorporated with organs, which are forms, and with forms incorporated with organs, which are kinds, and with kinds incorporated with organs, which are particles, all of the properties of matter are incorporated. Now, the animal body has consciousness because it has organs for the function, while the particles themselves have consciousness. Thus the body has consciousness as a body, as well as the particles, severally, of which it is composed. All of the mechanical bodies have consciousness and choice, but only in their particles; but animal bodies have organized consciousness, which is mind.

This is the conclusion we reach: Molecules, stars, rocks and plants have consciousness and choice only in their particles, but in animals consciousness and choice are organized as mind.

Hegel taught in his *Phenomenology* that every word, whenever used, has all its meanings, and he proceeded on this theory in the development of his logic. Mr. Ward seems to hold the same doctrine. I hold that whenever a word used in science is fundamental it should be used only in one sense, and this one sense should be retained throughout the discussion. Let me illustrate this: In metaphysic the word *quality* is used as synonymous with *property;* sometimes it is used to signify all of the properties and sometimes only one of them. Kind, as I have shown, is one of the properties, and it is very often used as a synonym for kind. I have tried to show in this book that it is used also to show the relation of bodies in their properties to human purposes, which relations are always either good or evil depending upon the point of view. Now, I have attempted and succeeded, as I believe, in using three terms for these three different meanings: *Properties* for the name of attributes that inhere in the object; *kinds* for the name of one property in all its degrees of relativity, and *qualities* to designate those attributes which arise through the relation of properties to purposes. I use the word *attribute* as a generic term which has two species—qualities and properties; and each of these species is again composed of five subspecies. This is offensive to Mr. Ward, not only in this particular case, but in all similar cases. In the book under consideration I have coined very few words, but I have tried in all fundamental cases to use a word always with the same meaning. There cannot be a science of psychology until its terms are used with constant meanings.

In folklore we often find seven to be a magical number; in the same manner we find nine and other numbers are considered magical—that is, they have occult meanings. The origin of these meanings goes back to savage cosmology. Now, Mr. Ward supposes that I use the number five as if it were magical. But let me assure him that the magic is not in the number. If I pay five dollars to every one of a hundred men because of labor performed, I shall not be accused of using five as a magical number, but

my conduct will be interpreted as my judgment of compensation. The significance of the terms used depends on the fact that there are five essential constants of matter found in every particle of the universe; these are unity, extension, speed, persistence, and consciousness. If the hypothesis that affinity is consciousness and choice fails, and affinity is still unexplained and consciousness is found only in animal bodies, then there are but four essentials in inanimate matter, while there are five in animate matter, and whenever a new animal body is evolved a fifth essential is evolved.

If the five essentials of properties are found in every body this should appear not only as affinity, but it should appear in a series in all bodies. This I have tried to show. I have called the essentials *concomitants*, and this term seems to offend Mr. Ward, but the term concomitant is used in the same sense in all modern and scientific psychology. Again, I have tried to show the nature of reciprocality; as, for example, when I set forth that quantities or properties that can be measured are the reciprocals of categories, or properties that can be classified. When I come to the second volume I shall greatly multiply these series and shall then systematize them into an argument; but I shall try not to make a pentalogic series where none exists, as Mr. Ward has done in the tables which he thinks he has compiled from my book. I find scientific men marshalled in three camps—one as champions of idealism, another as champions of dynamism, and a third rejecting all philosophy as vain. I have begun on the attempt to propound a Philosophy of Science.

J. W. POWELL.

ARTIFICIAL DREAMS.

TO THE EDITOR OF SCIENCE: Maury and some others have, to a certain extent, experimented on artificial dreams, but, at my instance, my students, Messrs. Matthews and Morley, undertook a series of experiments which may have some value in further illustrating the subject and pointing the way to further work. The method employed was for the one at an early hour in the morning to stimulate sensation in the other for a brief period, often 30 seconds, and then waken the dreamer, who at once recorded the dream. In general, the dreamer did not know beforehand what stimulus was to be applied.

The olfactory element in dreams being little recorded by experimenters, particular attention was paid to this point. Smell was slightly stimulated with heliotrope, and visual images mostly resulted, but in ten cases the dream was also olfactory, twice the dream being of a bunch of *Violets* and of smelling them. In a very strong stimulation of heliotrope the dream was of being choked with smell of perfume. This dream was in its early part composed of remarkable and vivid visual images. The dreamer flew on an air-ship through a snow-storm, and then over a country covered with white enamel and filled with white elephants, one of which pulled down the air-ship but soon released it, and then the whole herd flew off 'like so many butterflies.' This imagery has the characteristic quality of opium dreams.

In taste stimulation by salt and water there was a dream of eating olives.

In stimulating hearing repeatedly with a middle C tuning fork, within an interval of two weeks, a visual-auditory dream was repeated in 'every detail.' A fork in a lower octave gave dream of hearing fog horn, but no visual image. Another time it was the roar of a lion, but no visual image.

The record gives for temperature stimulation 2 pure temperature dreams, and 3 visual and temperature; for pressure stimulation 2 visual and pressure, for smell stimulation 1 pure smell and 6 pure visual and 10 visual and olfactory; for hearing stimulation 7 pure auditory, 6 visual and auditory.

These reports suggest that artificial dreams may be divided into three classes: First, the simple dream, where the stimulus is removed at the least sign of reaction, and the consequent dream is usually vague and momentary. Second, the cumulative dream, where the stimulus is continued and made to increase to even the highest point of excitation, and the dream has a definite intensifying development till the waking point. (An interesting dream would probably be produced by a metronome brought nearer and nearer, either directly or through a tube connected with the dreamer's ear.) The

third class is the complex dream which may be determined by different kinds of stimuli successively applied. These reports also suggest a practical matter that those who find dream pleasures a necessity, as the opium eater, might obtain a large measure of such pleasures by perfume and other stimuli which do not leave unhealthy reactions.

As to my own dreams I may mention a few facts which may be suggestive. My dreaming is commonly of places and persons which are totally unknown, but, of course, the types are familiar. I often dream of being in a crowd and studying faces which I have never seen before. Similarly I dream of being in a bookstore and picking up new books which I have never seen, and reading many pages, and looking at strange pictures. I once awoke from a vivid dream of this sort, and was able to recall several sentences, and to notice that they were far from my own style of writing, and had an individuality of their own which I could not recognize. But all this merely means that those in whom the constructive imagination is strong exercise it freely in sleep.

A singular case of dream stimulation is this: I dreamed of being in a strange hilly country, and a man appeared driving a tandem. In vain he sought to get up the hills, and the horses became so ludicrously tangled that I burst into loud laughter; this was heard in another room. In my laughter I heard other voices laughing, all from a single direction, but there was no visual image. It is highly probable that my dream of hearing others' laughter was stimulated by hearing my own laughter.

Maury makes the 'embryogeny of the dream' to consist in 'hypnagogic hallucination,' that is, in the stage of waking just previous to sleep visual and auditory hallucinations occur which are carried into sleep, but it appears to me that he lays much too great stress on the point. I noticed the other morning during a succession of cat-naps that the formation was not in any wise hallucinatory. Awake for a few seconds I thought of dressing, and had the images of the process but not hallucinatory, but knowing them to be ideas to be realized, but the senses quickly falling asleep, these images constituted a dream reality, I was really dressing. Very commonly our last waking thoughts turn into dream without any hallucinatory stage.

Hiram M. Stanley.
Lake Forest, Ill., January 23, 1899.

Trowbridge's Theory of the Earth's Magnetism.

In an article entitled 'The Upper Regions of the Air,' in the January number of the *Forum*, Professor John Trowbridge proposes a new theory to account for the phenomena of the earth's magnetism, of the northern lights and of thunder storms.

His theory, briefly stated, is that those waves of energy coming from the sun whose wave-lengths are of the order of those concerned in the X-ray phenomena are completely absorbed by the atmosphere and transformed into electric and magnetic energy in the upper regions of the air, and that being thus transformed they fail to manifest themselves as light at lower altitudes. According to Perrin and Winkelmann, the X-rays have the property of communicating an electric charge to conductors. "If, therefore, X-rays reach the earth from the sun they are competent to give an electrical charge to our atmosphere. The side, therefore, of the earth turned toward the sun would receive a charge in the upper good-conducting regions of the air. This charge would tend to dissipation, and there would be a flow of electricity toward the side of the earth not turned to the sun. The rotation of the earth on its axis from west to east would bring forward at each revolution fresh regions of the upper air to receive the electrical charging from the sun. There would be an accumulation of electricity on one side of the earth and a diminution of electricity on the other. The conditions of the equalization of the electrical charge, or the flow of electricity, might be determined by the direction of rotation of the earth. If this flow took place from east to west, just opposite to the direction of rotation of the earth, and were sufficiently powerful, it would produce the magnetic north and south poles. It has been found that air submitted to the action of the X-rays continues for some time to manifest their influence. We should, therefore, expect a fall of electric pressure between the regions just entering into daylight

and those in the full glare of the sun. This condition would direct the resulting electric current from east to west, or in the direction opposite to that of the earth's rotation."

The author says we have no good theory to account for the earth's magnetism unless we are ready to accept the one he has proposed. Let us see, then, how the well-known magnetic phenomena of the earth are accounted for by this theory.

First. The north end of the compass needle points approximately toward the north. Applying Ampere's rule to Trowbridge's currents flowing in the upper regions of the air from east to west we find that the north end of the needle would point *south*. Hence the author's currents must be reversed, *i. e.*, they must flow from west to east, or in the *same* direction as that of the earth's rotation.

Second. The north end of the dip needle points down in our latitude; hence applying Ampere's rule again, the electric currents must go in the clockwise direction around the needle, or, in other words, must proceed from east to west, or contrary to the direction of the earth's rotation. We should have, then, here a peculiar state of things. In order to satisfy the phenomena of the horizontal needle, Trowbridge's currents must go from west to east; to account, however, for the known facts of the dipping needle, they must simultaneously go in a contrary direction.

In short, *if electric currents produce the observed phenomena of the compass and of the dip needle they cannot be in the atmosphere, but must be inside the earth's crust and proceed from east to west.* Let the author apply Ampere's rule to these currents and he will find that they will now completely represent the known magnetic phenomena.

The fact that the causes of the earth's magnetism must be almost entirely *within* the earth's crust was shown mathematicalty by Gauss half a century ago and has been amply verified by the recent investigations of Schmidt. His elaborate mathematical analysis has resulted in the following conclusions:

The earth's magnetic force consists of three parts, viz: (1.) The greatest part; this is to be referred to causes *within* the earth's crust, and possesses a potential. (2.) The smallest part about 1-40 of the entire force; this is due to causes *outside* the earth's crust, and likewise possesses a potential. (3.) A somewhat larger part than the preceding; this does not possess a potential, and, in consequence, points to the existence of vertical earth-air electric currents. These currents amount, on the average, for the entire earth's surface, to one-sixth of an ampere per sq. km.

L. A. BAUER.

UNIVERSITY OF CINCINNATI.

I AM much obliged to Professor Bauer for his courteous criticism of my theory of terrestrial magnetism, and I am inclined to give great consideration to the opinion of such an authority on the earth's magnetism. I imagined, however, that the electrical currents were largely localized at the region of the astronomical poles of the earth, and I supposed, also, that the earth, as a whole, is para-magnetic.

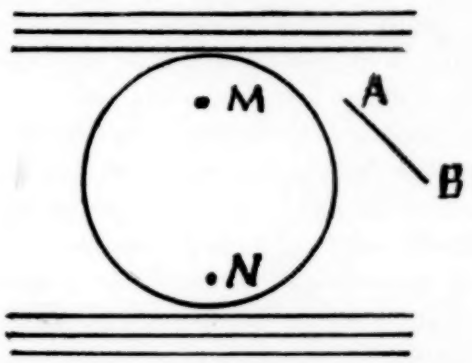

FIG. 1.

According to my theory, poles *M* and *N*, Fig. 1, might, perhaps, be formed in this magnetic matter, which would be competent to produce both inclination and declination of a magnet *A B*. Considerations of the earth's rotation and the temperature of the air currents led me to localize, so to speak, the electrical action at the poles of the earth. It has always seemed to me that Gauss' theory may be considered a mathematical theory, which would be true, considering the limited number of observations he had to work with, whether we suppose the earth's magnetic poles to be formed by currents in the crust of the earth or by rotary phenomena in the medium outside the earth.

JOHN TROWBRIDGE.

NOTES ON INORGANIC CHEMISTRY.

FURTHER studies of hydrozoic acid, HN_3, are given in the *Journal für praktische Chemie* by Professor Curtius and Dr. Rissom. All of its salts as far as known are anhydrous. Lithium hydrazoate explodes violently on heating, and thallium hydrozoate detonates by percussion; the other hydrazoates of the alkalies and alkaline earths are comparatively stable. When they are heated carefully in small quantities in thin glass tubes they decompose quietly with evolution of nitrogen and the metal is left in a pure condition. This is pointed out as being the easiest method of preparing small quantities of barium, strontium and calcium. In the light of Moissan's recent researches, it would be interesting to know if the residual substance on heating calcium hydrozoate is really metallic calcium, or calcium nitrid, which might readily be formed under these circumstances. The authors further find that a solution of the free hydrozoic acid decomposes to some extent on heating with dilute mineral acids, hence the amount of free acid obtained in this way from the salts is much less than the theoretical.

AN interesting synthesis from acetylene has been accomplished by Berthelot, according to the *Comptes Rendus*. Acetylene is led into fuming sulfuric acid, and the potassium salt of the acid thus formed is fused for a short time at 200° C. On acidification and distillation, phenol is easily recognized. This synthesis is peculiarly interesting from the fact that it is accomplished at such a low temperature.

THE work of Hantzsch and of others on the reactions of inorganic salts in other than aqueous solutions, and especially in solutions of non-electrolytes, is bearing much fruit in enabling the preparation of new inorganic compounds. Hantzsch has just described, in the *Zeitschrift für anorganische Chemie*, the disulfid of silver Ag_2S_2, corresponding to the recently discovered dioxid, Ag_2O_2. It is readily precipitated from a solution of silver nitrate in benzonitril, on adding a solution of sulfur in carbon bisulfid. It is a brown amorphous powder, insoluble in ordinary solvents, melts at a fairly high temperature, but rapidly decomposes, and oxidizes with great rapidity in the air when moist or in water. Other solvents, including pyridin, were tried in its preparation, but benzonitril was the only one found in which the disulfid could be formed.

J. L. H.

ZOOLOGICAL NOTES.

PROFESSORS W. C. HERDMAN and Rupert Boyce have presented to the Royal Society a further study of Oysters and Diseases (published in *Nature*), from which we take the following:

Although we did not find the bacillus typhosus in any oysters obtained from the sea or from the markets, yet in our experimental oysters inoculated with typhoid we were able to recover the organism from the body of the oyster up to the tenth day. We show that the typhoid bacillus does not increase in the body or in the tissues of the oyster, and our figures indicate that the bacilli perish in the intestine.

Our experiments showed that the sea-water was inimical to the growth of the typhoid bacilli. Although their presence was demonstrated in one case on the twenty-first day after addition to the water, still there appeared to be no initial or subsequent multiplication of the bacilli.

In our experiments in washing infected oysters in a stream of clean sea-water the results were definite and uniform; there was a great diminution or total disappearance of the typhoid bacilli in from one to seven days.

The colon group of bacilli is frequently found in shell-fish as sold in towns, and especially in the oyster; but we have no evidence that it occurs in mollusca living in pure sea-water. The natural inference that the presence of the colon bacillus invariably indicates sewage contamination must, however, not be considered established without further investigation.

The colon group may be separated in two divisions: (1) those giving the typical reactions of the colon bacillus, and (2) those giving corresponding negative reactions, and so approaching the typhoid type; but in no case was an organism giving all the reactions of the *B. typhosus* isolated. It ought to be remembered, however, that our samples of oysters, although of various kinds and from different sources, were in no case, so far as we are aware, derived

from a bed known to be contaminated or suspected of typhoid.

We have shown also the frequent occurrence, in various shell-fish from the shops, of anaërobic spore-bearing bacilli giving the characteristics of the *B. enteriitidis sporogenes* recently described by Klein.

As the result of our work, we make certain recommendations as to the sanitary regulation and registration of the oyster beds, and as to quarantine for oysters imported from abroad.

CURRENT NOTES ON ANTHROPOLOGY.

ETHNOGRAPHY OF LIBERIA.

IN *L'Anthropologie*, for August, the French Consular Agent at Monrovia, M. Delafosse, gives a sketch of the present ethnography of Liberia. The colored immigrants from the United States, usually with more or less white blood in their veins, have mixed indiscriminately and largely 'de la main gauche' with the native inhabitants. They form a particolored population, not of a promising character. The indigenous languages belong to four stocks, the Mande, the Kru, the Gola and the Guele, the last mentioned being that of the cannibal tribes on the southeast. The original people of this part of the coast were the Dé, who were related to the Kru tribes and those of the Ivory Coast. The Vei belong to the Mande (or Mandingo) stocks, and are interesting as using a peculiar syllabic alphabet, first observed by Lieutenant Forbes, U. S. N. M. Delafosse says that it was not their invention, as has been stated, but was borrowed by them from some tribe near the source of the Niger.

THE SIGNIFICANCE OF SKULL-MASKS.

THE use of skulls, or imitations of them, as masks, was not uncommon in America, and is quite frequent in Polynesia. Their symbolism and signification are examined by L. Frobenius in the *Internat. Archiv für Ethnographie* (1898, Heft IV.). Rejecting former and incomplete suggestions, he finds this custom arose from that of the adoration of skulls themselves. It is well known that in primitive religion the skulls of men and animals are conspicuous objects of worship, as representing the spirits of the departed. This was connected with the religious homage to ancestors, to deceased chieftains and to the brute eponymous forefathers of the totem. Sometimes the symbolism of the skull in the mask was reduced merely to the insertion of teeth or some such single feature.

THE SVASTIKA IN AMERICA.

THAT a simple figure, like the Svastika, may arise independently, representing quite different objects, is again illustrated by Mr. Wm. W. Tooker in an article in the *American Antiquarian* for December. Among the marks which were tattooed on the backs of the Virginian Indians as totemic designs we find the Svastika, as Mr. Tooker says, 'in full bloom.' In this instance, from other figures given, the design seems to represent four tomahawks crossed in pairs, the blades in opposite directions. But, as Mr. Tooker remarks, "It is a simple figure which, when compared with others of aboriginal origin, might be evolved from an Indian's brain," without evoking the hypothesis of a foreign immigration. As a 'symbol' it has no constant and universal meaning, and the mystical importance which has been attached to it by some imaginative writers has no foundation in facts.

D. G. BRINTON.
UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

DR. P. L. SHERMAN, formerly instructor in general chemistry in the University of Michigan, has gone with Professor Worcester to the Philippines as his secretary.

DR. I. BORNMÜLLER has gone to northern Persia on a botanical expedition.

THE Berlin Academy of Sciences has made a grant of 2,400 Marks toward the expenses of a botanical expedition to Java by Dr. Paul Knuth.

THE herbarium of Professor Chodat, of the University of Geneva, has been destroyed by fire.

REPRESENTATIVE SAMUEL J. BARROWS, of Massachusetts, will be appointed Librarian of the National Library. This is regarded as an excellent appointment, that will insure the conduct of the Library without reference to politi-

cal considerations. The position was first offered to Mr. Herbert Putnam, head of the Boston Public Library.

Professor William Osler, F.R.S., of the Johns Hopkins University, Baltimore, has accepted an invitation to deliver the Cavendish lecture for 1899, before the West London Medico-Chirurgical Society.

The report is circulated that the remains of Andrée and his companions and the car of the balloon have been found between Kemo and Pit, in the province of Yeniseisk, Siberia.

Dr. R. F. Claus, the eminent zoologist professor in the University of Vienna, has died at the age of 63 years.

The London *Times* announces the death of the Rev. Thomas Hincks, F.R.S., at Clifton, on January 26th. He was the son of the late Rev. William Hincks, F.L.S., and was born at Exeter in 1818. He was for many years a Unitarian minister, but had a wide reputation as an authority in several departments of marine zoology, being the author of a history of the British Hydroid Zoophytes, published in 1868, and a history of the British Marine Polyzoa, published in 1889. Both these books are largely the results of his own investigations. He was elected into the Royal Society in 1872, and continued to be an active worker in science until very lately.

We regret also to record the death of Dr. Hampe, professor of chemistry in the School of Mines at Clausthal, aged 57 years.

The House Committee on Appropriations has recommended an increase of $4,200 in the annual appropriation for scientific work of the United States Fish Commission; the entire amount now available for the Department of Scientific Inquiry being $15,000. This increase is the more gratifying since it is made after an examination of the practical results that have attended the lines of scientific research carried on during the past year.

A bill has been introduced into the New York Assembly appropriating $30,000 to continue the promotion of the sugar beet industry, of which $2,500 is devoted to making experiments by the Commissioner of Agriculture.

The American Mathematical Society will hold a regular meeting in Room 301 of Fayerweather Hall, Columbia University, on Saturday, February 25th. The two sessions begin at 10:30 a. m. and 2:30 p. m.

At the annual meeting of the Washington Academy of Sciences recently held, the following officers were elected for the ensuing year: President, Chas. D. Walcott; Vice-Presidents: Anthropological Society, W J McGee; Biological Society, F. V. Coville; Chemical Society, H. N. Stokes; Entomological Society, Dr. H. G. Dyar; Geographic Society, G. K. Gilbert; Historical Society, A. R. Spofford; Medical Society, Dr. S. C. Busey; Philosophical Society, O. H. Tittmann; Secretary, Frank Baker; Treasurer, Bernard R. Green; Managers: Class of 1902: L. O. Howard, J. W. Powell, Carroll D. Wright; Class of 1901: Marcus Baker, Henry S. Pritchett, Geo. M. Sternberg; Class of 1900: F. W. Clarke, C. Hart Merriam, Lester F. Ward. The Academy has arranged for a course of popular lectures on scientific subjects to be given during the months of March and April. A number of demonstrations will also be given on topics of special interest. The first of these was held on the evening of January 31st, and related to Developments in the Art of Recording and Reproducing Sounds, with an exhibition of the new graphophone recently perfected in the Volta Bureau of Mr. Alex. Graham Bell. A welcome donation to the Academy was recently made by Mrs. Gardiner Hubbard, who in view of the life-long interest in science shown by her deceased husband, presented the sum of $1,000 as a token of her desire to aid in the advancement of science and the union of the scientific interests in Washington. The Academy showed its appreciation of her generosity by at once electing her a patron. Arrangements have been made for the publication of the Proceedings of the Academy. The 'brochure' plan will be adopted, each separate to have its own pagination as well as that of the volume, and to be dated with the actual date of delivery to members. Several papers have already been presented for publication, and it is evident that more funds than are at present available could advantageously be spent for this purpose.

THE Anthropological Society of Washington and the Woman's Anthropological Society have recently united for scientific work, the latter discontinuing separate scientific meetings, and the former modifying its by-laws in such manner as to combine the functions hitherto performed by the two organizations. The union was definitely completed at the annual meeting of the Anthropological Society of Washington on January 17, 1899, at which the modified by-laws were adopted, and at which representatives of both societies were recognized in the ensuing election of officers. The officers for the year are as follows: President, W J McGee; Vice-Presidents—Section A, Somatology, Dr. Frank Baker; Section B, Psychology, Lester F. Ward; Section C, Esthetology, W. H. Holmes; Section D, Technology, Frank Hamilton Cushing; Section E, Sociology, Dr. George M. Kober; Section F, Philology, Major J. W. Powell; Section E, Sophiology, Alice C. Fletcher; General Secretary, Jessie Moore Holton; Treasurer, Perry B. Pierce; Curator, Mariana P. Seaman; Secretary of the Board of Managers, Dr. J. H. McCormick; Councilors, J. Walter Fewkes, Weston Flint, F. W. Hodge, George R. Stetson, Edith C. Westcott, Thomas Wilson; Ex-Officio Members of the Board (as Ex-Presidents), Robert Fletcher, Otis T. Mason.

THE National Geographic Society offers two prizes for the best essays on Norse discoveries in America—a first prize of $150 and a second prize of $75. Essays submitted in competition for these prizes should be typewritten in the English language and should not exceed 6,000 words in length. They should be signed by a pseudonym and must be received on December 31, 1899. The judges are: Henry Gannett, Geographer of the U.S. Geological Survey, etc.; Albert Bushnell Hart, professor of history in Harvard University; Anita Newcomb McGee, M. D., Acting Assistant Surgeon, U. S. A.; John Bach McMaster, LL. D., professor of history in the University of Pennsylvania, and Henry S. Pritchett, Superintendent of the U. S. Coast and Geodetic Survey.

A PROVISIONAL committee for the German Empire, in connection with the Thirteenth International Medical Congress, which is to be held in Paris in 1900, has been formed, with Professor Rudolph Virchow as President.

As we have already announced, the eighth session of the International Geological Congress will be held in Paris from August 16 to 28, 1900, in connection with the great Exposition. The *American Geologist* states that the Committee of Organization, of which M. Albert Gaudry is President, MM. Michel-Lévy and Marcel Bertram, Vice-Presidents, and M. Charles Barrois, General Secretary, has already held several meetings. The Congress will meet in a special pavilion, and the length of its sessions will permit its members to visit the Exposition and the geological museums of Paris. Three general excursions have been arranged in addition to nineteen excursions intended for specialists, in which the number of members who can attend is limited to twenty. A circular describing the plans for these excursions will be sent out in 1899, and a guide book written by the directors of the excursions will be placed on sale at the beginning of 1900.

DR. CHARLES MOHR, of Mobile, Ala., Special Agent of the Forestry Division of the United States Department of Agriculture, has recently presented to the Museum of Pharmacognosy of the University of Michigan some interesting and valuable specimens. They consist of a section of a pine-tree trunk, showing the American method of boxing and bleeding long-leafed pines for turpentine; and of samples of the twenty different turpentine products manufactured in the South. The various stages of the manufacture of turpentine are well illustrated by these specimens.

CONSUL AYERS, of Rosario, under date of December 9, 1898, writes the Department of State that by reason of the continuous onslaught made on the locusts through the efforts of the commissions, aided by a lately developed natural enemy—the Champi beetle—the injury to the crops so far has been very slight. The consul incloses a letter by an American—Maj. O. C. James—describing the beetle, which, it appears, feeds upon the eggs of the locust. The letter reads, in part: "The 'Champi' is the most effective locust-egg destroyer we have in Argentina. He is a dirty blackish beetle, the

larger species being a little more than 1 inch long by half an inch broad, and must be looked for closely where locusts are laying their eggs or his presence may not be discovered. Both the mature insect and its larvæ feed upon the eggs of the acridian in large numbers. These beetles belong to the genus *Trox* of the family *Scarabæidæ*. Ordinarily they feed upon dead animals and animal matter more or less desiccated. How they have developed the habit of feeding upon locusts' eggs is a mystery. Still, it might be imagined that the steps from a carrion-feeding habit could develop that which the insects now possess. In a country where hundreds of dead animals are left scattered over the pampa to decay, these insects have become plentiful. The eggs of the locusts are covered with a frothy exudation that soon becomes strong smelling and attracts the beetles, who devour them." Under date of December 6th, Consul Ruffin, of Asuncion, writes that among the worst pests with which Paraguay is infested are the grasshoppers, which are almost as large as small birds. The name of locust is given them, but they are more like what we call grasshoppers. A government commission to study the question of their extermination has been appointed, and in the last few days a law compelling everybody to help kill the grasshoppers or pay a fine of $20 paper (equal to about $2.75 gold) has been passed. The young ones, unable to fly, are killed, the method being to drive them into a long trench and cover them up. The grasshoppers, sometimes for a whole day, obscure the brilliant tropical sun in their flight and make it appear as though the weather were cloudy; they also impede railroad trains.

The Weather Bureau office in New York City was moved on October 15, 1898, from the Manhattan Building, No. 66 Broadway, to the American Surety Building, No. 100 Broadway, about two blocks farther north. The monthly *Weather Review* gives some details in regard to the old and the new offices. The office quarters in the Manhattan Building consisted of four circular rooms, one immediately above the other, in the tower that rises to an altitude of about 88 feet above the main roof and 355 feet above the curbstone on Broadway. Communication between the four rooms was by means of a central spiral scaircase. The barometer was in the first or lower room. Owing to the presence of the tower and the general configuration of the roof it was necessary to give the anemometer, wind vane and thermometers a much greater elevation than would be afforded by the ordinary supports. The thermometer shelter support consisted of a skeleton framework of iron, high enough to give the thermometers an elevation of 54 feet above the main roof. Access to the shelter was secured by means of a spiral staircase, the iron newel of which extended upward about 34 feet above the top of the framework as a support for the wind vane and anemometer. The last-named instruments were thus placed at an elevation of 326 feet above the curb, but still some distance below the top of the main portion of the tower. This station was thus occupied from March 15, 1895, to October 15, 1898. The office quarters secured in the American Surety Building consist of five rooms *en suite* on the twentieth floor, the next but one to the top of the building. The roof of the building on which the instruments are exposed is almost flat and there are no projecting towers or chimneys on the building itself or surrounding structures to obstruct the free sweep of the wind. The barometer is at the same elevation as in the Manhattan Building. The heights of the instruments above the Pine street curb and the roof are now as follows:

Instruments.	Above curb. *Feet.*	Above roof. *Feet.*
Barometer	276	.....
Thermometer	313	11.0
Anemometer cups	345	43.5
Wind vane	322	19.8
Rain gauge	305	3.2

The Boston Society of Natural History, in order to meet a considerable loss of income due to the lower rate of interest now paid upon conservative investments, and also that the efforts of the Society may keep abreast of the new demands arising from the growth of the metropolitan district of Boston, needs additional members. From the statement sent with this appeal we take the following facts regarding the Society: The Boston Society of Natural History was founded April 28, 1830, for 'the en-

couragement and promotion of the science of natural history.' It was incorporated February 25, 1831, and has long been one of the eminent and essentially public institutions of the community. The Society contributes at present to the promotion of science and of public education by the following means: (1) Meetings held on the evenings of the first and third Wednesdays of each month from November to May. These meetings are devoted to the presentation of the results of scientific investigations and to the popular expositions of such studies as are of general public interest. (2) Publication of Memoirs, Proceedings and Occasional Papers, which all record the discoveries of members and others. These publications are widely distributed in all parts of the world, more than four hundred copies being sent to academies, learned societies and other correspondents, as well as to such members of the Society as express a wish to receive them. (3) The Library, which contains upwards of 25,000 volumes and 12,000 pamphlets, includes numerous extensive sets and rare works, many of them not accessible elsewhere in this vicinity. Members are allowed eight volumes at a time for home use, and each volume may be retained a month without renewal. The library privileges are granted without reference to residence. Books are sent by express at the borrower's expense. (4) The Museum contains the collections of the Society and is open to the public on two days of each week. The number of visitors is large on those days. The Museum is open to members on other days. Special efforts have been made to display the fauna, flora and geology of New England. To increase the educational value of the collections, printed guides have been placed on sale. (5) Lectures to teachers and others, which at present are largely maintained by the Trustees of the Lowell Institute.

UNIVERSITY AND EDUCATIONAL NEWS.

IT is announced that a donor, whose name is withheld, has endowed in Harvard University a chair of hygiene.

MAXEY HALL, Brown University, has been injured by fire, the damage being estimated at $25,000.

DR. JAMES MONROE TAYLOR has been elected President of Brown University. Dr. Taylor has been, since 1886, President of Vassar College, where his administration has been very successful.

DR. THOMAS J. SEE, well known for his important researches in astronomy, has been nominated for a professorship of mathematics at the Naval Academy, Annapolis.

MR. W. L. CASCART has been appointed adjunct professor of mechanical engineering in Columbia University. At the same meeting of the Trustees the title of Professor R. S. Woodward was changed from professor of mechanics to professor of mechanics and mathematical physics.

PROFESSOR FRITZ REGEL, of Jena, and Dr. Erich v. Drygalski, of Berlin, have been appointed to professorships of geography in the Universities at Würzburg and Tübingen respectively.

DR. ROBERT OTTO, professor of chemistry in the Institute of Technology at Braunschweig, has retired. Dr. Voswinckel has qualified as docent in chemistry in the Institute of Technology at Berlin.

ACCORDING to the new catalogue of Brown University 925 students are enrolled, an increase of 65 over last year. The increase of the Freshman class, from 168 last year to 216 this, is especially noticeable. There are 99 graduate students.

IN a recent number of the *Harvard Graduates' Magazine*, Professor A. B. Hart publishes a comparative statement of the attendance at the leading American universities. According to his figures the institutions rank in numbers as follows:

Undergraduates in arts and sciences: Harvard, 2,260; Yale, 1,755; Michigan, 1,429; Wisconsin, 1,097; Columbia, 802; Chicago, 783; Pennsylvania, 653; Johns Hopkins, 187.

Graduate students: Chicago, 370; Harvard, 319; Columbia, 313; Yale, 270; Johns Hopkins, 192; Pennsylvania, 151; Wisconsin, 87; Michigan, 73.

The medical department: Pennsylvania, 793; Columbia, 695; Harvard, 546; Michigan, 408; Johns Hopkins, 201; Yale, 112.

The law department: Michigan, 720; Harvard, 543; Columbia, 341; Pennsylvania, 312; Yale, 195.

The following details are now given in regard to the establishment in Bombay of an Imperial University for India. Mr. Jamsetjee N. Tata offers a property representing a capital of over £200,000 and calculated to yield a yearly income of nearly £10,000 for the establishment of an Imperial University or a Research Institute, in order to supply the want of a higher course of post-graduate instruction in scientific research for the best students of the existing universities. A provisional committee has drafted, for the approval of the government of India, a bill which provides for a scheme of studies with a threefold division: (1) scientific and technological; (2) medical and sanitary, and (3) educational and philosophical. The last of these branches has been included in the scheme in order to give the institution the character of a university. The new institution seeks to have the power of granting degrees and diplomas, and as it proposes to offer a strictly post-graduate course of studies it will not in any way interfere with the working of any of the existing universities. The scheme of the provisional committee involves an expenditure larger than is provided for by Mr. Tata's generous offer. A grant in aid, therefore, will be asked for from the government of India. The support of native princes, of local governments and of the public generally will be sought. It is estimated that the initial expenditure required will amount to over £100,000 and the annual charge to about £20,000. On this basis, therefore, it is proposed to establish the several departments by degrees and to found subsequently special chairs through public and private munificence.

The following statements from a circular of the German Colonial School at Witzenhausen should be of special interest to Americans at the present time, as showing what Germany is doing to promote the education of men who intend to engage in industrial enterprises in her colonies. Similar institutions are maintained in Belgium and Holland. The purpose of this school, we quote from an announcement sent by the Division of Publications of the Department of Agriculture, is to educate young men to become practical superintendents of estates and plantations, planters, agriculturists, stock raisers and merchants for the German colonial possessions. The course of study, which is completed in two years, comprises the following studies: Plant culture in general, including the study of soils, climate and fertilizers, farm management, bookkeeping, mechanics, engineering (bridge and road building, drainage, irrigation); special plant culture, animal husbandry and dairying; culture, use and value of tropical plants; establishment of plantations; gardening; fruit culture; vegetable culture; viticulture; forestry; geology, with special reference to tropical mining; botany (physiology, anatomy, systematic and geographical); chemistry, with laboratory practice; surveying and drafting; hygiene for tropical countries; veterinary science; colonial history and geography; a study of the people; the history of education, religion and missionary work; colonial government, and commercial laws and relations; languages; trades (carpenters, masons, blacksmiths, harness-makers, bakers, butchers, etc.); practical work in field, garden, vineyard, forest, dairy, etc.; athletics (sports) of all kinds.

Professor W. A. Herdman, F.R.S., remarks in the twelfth annual report of the Liverpool Marine Biological Committee, says *Nature*, that there are two practices in American universities which excite the envy of professors in England. One is the 'sabbatical year'—the one year in every seven given for purposes of travel, study and investigation. The other is the frequent endowment of an expedition—or equipment of an exploring party—by an individual man or woman who is interested in the subject and can give a special fund for such a purpose. Columbia University, in New York; the Johns Hopkins University, in Baltimore; Yale University, in New Haven, and Harvard, at Cambridge, have all been benefited immensely in the past by such exploring expeditions. Nearly every year of late has seen one or more of such, due to private generosity, in the field; and the work they have done has both added to general scientific knowledge, and has also enriched with collections the laboratories and museums of the college to which the expedition belonged.

Erratum: Vol. IX., p. 174. Line 12 from bottom of second column, for *Australia* read *Austria*.